



United States Environmental
Protection Agency
Washington, DC 20460

**Interagency Agreement/
Amendment**

Part 1 - General Information

1. EPA IA Identification Number DW-14-95822901 - 1		2. Funding Location by Region EPA R5							
		3. Other Agency IA ID Number (If known)							
		4. Awarding Office IASSC East							
5. Type of Action Augmentation: Increase		6. IA Specialist: Lakeyshla Halrston 202-564-5322 Halrston.Lakeyshla@epa.gov							
7. Name and Address of EPA Organization US Environmental Protection Agency IASSC East 1200 Pennsylvania Avenue, NW Mail code 3903R Washington, DC 20460 9. DUNS: 029128894		8. Name and Address of Other Agency Department of the Interior Great Lakes Science Center USGS Great Lakes Science Center / 1451 Green Road Ann Arbor, MI 48105 11. DUNS: 161182266							
10. BETC: DISB		12. BETC: COLL							
13. Project Title and Description Great Lakes Restoration Initiative Implementation and measurement by USGS Pursuant to the Department of Defense Appropriations Act, 2012, Public Law 12-74 EPA is providing resources to United States Geological Service (USGS) to implement strategic priority actions and activities within their respective statutory authorities to measurably advance the goals of the Great Lakes Restoration Initiative Action Plan. Among other activities, USGS will under take a number of activities to restore and protect the Great Lakes ecosystem through: assessments of conditions and results of GLRI project implementations in Areas of Concern, embankments, river mouths and targeted watershed; application of science for controlling invasives, nutrients and botulism. Increase in funding									
14. EPA Project Officer (Name, Address, Telephone Number) Judy Beck 77 West Jackson Blvd. (G-17-J) Chicago, IL 60604-3507 312-353-3849 E-Mail: Beck.Judy@epamail.epa.gov FAX:		15. Other Agency Project Officer (Name, Address, Telephone) Norman G. Grannemann USGS Great Lakes Science Center / 1451 Green Road Ann Arbor, MI 48105 517-887-8936 E-Mail: nggranne@usgs.gov FAX: 517-887-8937							
16. Project Period: 06/06/2012 to 09/30/2016		17. Budget Period: 06/06/2012 to 09/30/2016							
18. Scope of Work (See Attachment) Revised Scope of Work Attached.									
19. Employer/Tax ID No. 520852695		20. CAGE No: 347A4							
21. ALC: 68-01-0727		23. Other Agency Type Federal Agency							
22. Statutory Authority for Transfer of Funds and Interagency Agreement Clean Water Act: Sec. 104(b)(2); Consolidated Appropriations Act; 2012; Public Law 112-74									
24. Revise Reimbursable Funds and Direct Fund Cites (only complete if applicable)									
	Previous Funding	This Action	Amended Total						
Revise Reimbursable (in-house)		0	0						
Direct Fund Cite (contractor)		0	0						
Total			0						
Funds	Previous Amount	Amount This Action	Total Amount						
25. EPA Amount	\$12,431,961	\$619,805	\$13,051,766						
26. EPA In-Kind Amount			\$0						
27. Other Agency Amount		\$0	\$0						
28. Other Agency In-Kind Amount			\$0						
29. Total Project Cost	\$12,431,961	\$619,805	\$13,051,766						
30. Fiscal Information									
Treas. Symbol	DCN	FY	Appropriation	Budget Org	PRC	Object Class	Site/Project	Cost Org	Ob/De-Ob Amt
682/30108	1305HAX004	1213	B	05HO0	202BJ7XF5	2506			31,770
682/30108	1305HAX004	1213	B	05HO0	202BJ7XF5	2506			171,635
682/30108	1305HAX004	1213	B	05HO6	202BJ7XF2	2506			416,400
									619,805

Part II - Approved Budget

EPA IAG Identification Number

DW-14-95822901 - 1

31. Budget Categories	Itemization of All Previous Actions	Itemization of This Action	In-Kind Itemization of This Action	Itemization of Total Project Cost to Date
(a) Personnel	\$4,505,784	\$241,679		\$4,747,463
(b) Fringe Benefits	\$1,317,498	\$64,715		\$1,382,213
(c) Travel	\$730,918	\$18,875		\$749,793
(d) Equipment	\$850,288	\$30,000		\$880,288
(e) Supplies	\$0			\$0
(f) Procurement / Assistance	\$4,275,143	\$177,595		\$4,452,738
(g) Construction	\$0			\$0
(h) Other	\$137,366	\$55,950		\$193,316
(i) Total Direct Charges	\$11,816,997	\$588,814	\$0	\$12,405,811
(j) Indirect Costs:	\$614,964	\$30,991		\$645,955

Charged - Amount

Rate: 5%

Base: \$11,816,997.00

Not Charged:

Funds-Out: Not charged by Other Agency

Estimate by other Agency

Amount \$

(k) Total (EPA Share 100.00 %) (Other Agency Share 0.00 %)	\$12,431,961	\$619,805	\$0	\$13,051,766
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32. How was the IDC Base calculated?

33. Is equipment authorized to be furnished by EPA or leased, purchased, or rented with EPA funds? ☒ Yes ☐ No

(Identify all equipment costing \$1,000 or more)

34. Are any of these funds being used on Procure/Assistance agreements? ☒ Yes ☐ No

Type of Procure/Assistance Agreement Cooperative Agreement; Contract

Contractor/Recipient Name (if known)	Total Procure/Assistance Amount Under This Project	Percent Funded by EPA (if known)
Various	4452738 Total \$ 4,452,738.00	100

Part III - Funding Methods and Billing Instructions

35. (Note: EPA Agency Location Code (ALC) - 68010727)

<input checked="" type="checkbox"/> Disbursement Agreement	Request for repayment of actual costs must be itemized on SF 1080 and submitted to the Financial Management Office, Cincinnati, OH 45268-7002;
<input checked="" type="checkbox"/> Repayment	<input checked="" type="checkbox"/> Monthly <input type="checkbox"/> Quarterly <input type="checkbox"/> Upon Completion of Work
<input type="checkbox"/> Advance	Only available for use by Federal agencies on working capital fund or with appropriate justification of need for this type of payment method. Unexpended funds at completion of work will be returned to EPA. Quarterly cost reports will be forwarded to the Financial Management Center, EPA, Cincinnati, OH 45268-7002.
<input type="checkbox"/> Allocation Transfer-Out	Used to transfer obligational authority or transfer of function between Federal agencies. Must receive prior approval by the Office of Comptroller, Budget Division, Budget Formulation and Control Branch, EPA Hdqrs. Forward appropriate reports to the Financial Reports and Analysis Branch, Financial Management Division, PM-226F, EPA, Washington, DC 20460.

36. ☐ Reimbursement Agreement ☐ Repayment ☐ Advance☐ Allocation Transfer-In

Other Agency's Billing Address (Include ALC or Station Symbol Number)

Other Agency's Billing Instructions and Frequency

Part IV - Acceptance Conditions

EPA Identification Number

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37. Terms and Conditions, when included, are located at the end of the 1610-1, or as an attachment.

Part V - Offer and Acceptance

Note: A) For Fund-out actions, the agreement/amendment must be signed by the other agency official in duplicate and one original returned to the Grants and IA Management Division for Headquarters agreements or to the appropriate EPA Regional IA administration office within 3 calendar weeks after receipt or within any extension of time that may be granted by EPA. The agreement/amendment must be forwarded to the address cited in item 29 after acceptance signature.

Failure to return the properly executed document within the prescribed time may result in the withdrawal of offer by EPA. Any change to the agreement/amendment by the other agency after the document is signed by the EPA Award Official, which the Award Official determines to materially alter the agreement/amendment, shall void the agreement/amendment.

B) For Funds-In actions, the other agency will initiate the action and forward two original agreements/amendments to the appropriate EPA program office for signature. The agreements/amendments will then be forwarded to the appropriate EPA IA administration office for signature on behalf of the EPA. EPA will return one original copy after acceptance returned to the other agency after acceptance.

EPA IA Administration Office (for administrative assistance)

EPA Program Office (for technical assistance)

38. Organization/Address

U.S. Environmental Protection Agency
IASSC East
1200 Pennsylvania Avenue, NW Mail code 3903R
Washington, DC 20460

39. Organization/Address

US Environmental Protection Agency
R5 - Region 5
77 West Jackson Blvd.
Chicago, IL 60604-3507

Award Official on Behalf of the Environment Protection Agency

40. Digital signature applied by EPA Award Official | FOR Frank N. Roth - Chief Fellowship IA & SEE Branch
Michelle Messick - AO delegate

Date

01/16/2013

Authorizing Official on Behalf of the Other Agency

41. Signature

Typed Name and Title

Date

Leon Carl, Director, Midwest Region

1-25-13

Great Lakes Restoration Initiative

Interagency Agreement

Scope of Work

AGENCY NAME: U.S. Geological Survey

CONTACT INFORMATION: Norman Grannemann (517-887-8936)

1. INTRODUCTION

Recognizing that the Great Lakes ecosystem is an invaluable resource containing over 20% of the world's surface freshwater and providing drinking water to over 40 million people, the Administration, in 2009, announced the Great Lakes Restoration Initiative (GLRI) to protect, restore and maintain the Great Lakes ecosystem. In conjunction with 15 other Federal Agencies, the USEPA will implement strategic, priority actions to achieve the vision of a restored, protected and sustainable Great Lakes ecosystem.

The purpose of this Interagency Agreement (IA) is to provide funding to the U.S. Geological Survey (USGS) to help implement the priorities of the GLRI. Specifically, this IA will implement priority programs, projects, and activities to protect, restore and maintain the Great Lakes ecosystem. This IA will also utilize USGS to implement priorities, programs and projects of the Great Lakes Water Quality Agreement such as the Lakewide Management Plans, the Remedial Action Plans for Areas of Concern, the Binational Toxics Strategy, and the Cooperative Science and Monitoring Initiatives, among others.

The GLRI Action Plan identifies goals, objectives, measurable ecological targets, and specific actions for five focus areas—Toxic Substances and Areas of Concern; Invasive Species; Nearshore Health and Nonpoint Source Pollution; Habitat and Wildlife Protection and Restoration; and Accountability, Education, Monitoring, Evaluation, Communication and Partnerships.

Milestones from Past GLRI Funding

- **Native Fish Restoration** -- Approximately 65,000 fall fingerling Atlantic salmon were released in Lake Ontario tributaries in September 2011. Another 8,000 fall fingerling salmon were released in St. Lawrence River tributaries in October in partnership with the St. Regis Mohawk Tribe.
- **Wetland Restoration** -- Through extensive partnerships with the U.S. Fish and Wildlife Service and Ducks Unlimited, a fish passage structure was constructed at Ottawa National Wildlife Refuge to restore hydrologic connection between a 100-acre coastal wetland and Lake Erie waters for the first time in nearly 40 years. Intense data collection by USGS and close interaction with refuge managers have led to an unprecedented look at the system response to a large wetland restoration action, implementation of adaptive management practices, and recognition of water quality improvements associated with habitat restoration in the Maumee River Area of Concern.
- **Phragmites Control** -- Extensive work by Dr. Rusty Rodriguez at the USGS – Western

Fisheries Research Center has identified several fungal endophytes in *Phragmites*. This is significant because no one else had successfully isolated and identified endophytes in *Phragmites* previously. This discovery allows the project to continue its work to examine the symbiotic relationship between endophytes and its host invasive plant and seek ways to target this relationship as a form of control. The end result could be an innovative management tool that is unlike conventional chemical, mechanical, or biological methods of control.

- **USGS Support for LaMPs** -- Template 330 provided continued support of coordinating activities with LaMP partners. Emphasis was placed on extending work completed for the Lake Michigan data web-mapper to all of the Great Lakes with the goal of expanding on previous efforts, resulting in recognition of areas where data are missing or sparse or where ecosystems are vulnerable. Scientists worked closely with partners. In Lake Huron, emphasis focused on issues affecting fisheries and nutrient inputs. For Lake Superior, emphasis was placed on support of data activities in areas with potential for mining development. For Lake Michigan, efforts included compilation of historic data into the web-mapper as well as support of a near-shore white paper. Lake Ontario efforts focused around attending LaMP meetings and providing science expertise for collecting benthos data to provide information to help EPA Region 2 make decisions on delisting the St. Lawrence-Massena AOC. For Lakes Erie and Huron emphasis was placed on coordinating activities with partners. Activities of the Great Lakes Science Center included coordinating activities with partners in each of the Great Lakes and on support for near-shore sampling and monitoring activities.
- **Huron-Erie Corridor Fish Restoration** -- Funding provided by Template 70 resulted in development of innovative sampling techniques to assess fish spawning and nursery habitat use in deep riverine systems in the St. Clair and Detroit rivers which documented spawning by several native fishes on remnant natural and recently constructed habitats to include rare, threatened, and endangered fishes as well as locally and regionally important sport and commercial fishes.
- **Avian Botulism** -- Funding for Template 73 resulted in development of an *in vitro* assay to detect type-E botulism toxin (BoNT/E). This assay has equivalent sensitivity and specificity to the “gold-standard” mouse bioassay, and is a major step forward in the study of botulism. The assay is now being tested on environmental samples (e.g., sediment). A citizen science program was established: Lake Michigan Volunteer AMBLE (Avian Monitoring for Botulism Lakeshore Events). We now have increased knowledge of timing, numbers, and species affected by avian botulism by increasing shoreline.
- **Lake Michigan Fishery Expertise for Native Fishery Restoration** -- Funding for Template 74 resulted in completion of a Lake Michigan Ecosystem Model that is being used by fishery managers to explore different stocking scenarios to support restoration of native lake trout.
- **Data for Phosphorus and Toxic Contaminant Loading to the Great Lakes** -- Thirty monitoring sites have been outfitted with automated samplers and real-time water-quality sondes. Data collected at these sites include nutrients, chloride and other major ions, and suspended sediment. Sondes measure dissolved oxygen, turbidity, specific conductance, pH, and temperature. Data from sondes will be used to develop regression relationships with water-quality variables to provide cost-effective monitoring in the future.
- **Beach Health** -- Currently 51 beaches (3 IL, 6 IN, 6 MI, 5 NY, 11 OH, 10 PA, 10 WI) are in the process of developing real-time models that will allow beach managers to improve decision-making. Many of these models will be available for active use during the 2013

beach season with the remainder available in the 2014 season.

- **Pathogen Analysis for Beaches and Watersheds --** Over 400 samples were obtained from 12 Great-lakes beaches and in summer of 2010, for genes indicating pathogenic bacteria in the genera *E. coli*, *Enterococcus*, *Salmonella*, *Shigella*, *Campylobacter* and *Staphylococcus*. These samples will enable a comparison between the indicators currently being used and actual human pathogen occurrence.
- **Methyl-Mercury Sampling and Analysis in Great Lakes Water Column --** Completion of three basin-wide sampling efforts (August 2010, April 2011, and August 2011) of the water column, bottom sediments, benthic fauna, and zooplankton across the entire Great Lakes Basin (about 80 sampling locations in total for each cruise). Data from these efforts have revealed a previously unknown source of methyl-Mercury (mid-water column methylation) that likely is the dominant source leading to elevated concentrations throughout the Great Lakes.
- **Indicator Bird Species Contaminant Information for BUI Removal at AOCs -- Baseline** contaminant information was collected from across the Great Lakes in tree swallows as well as other colonial waterbirds. In addition to the 22 Great Lakes locations evaluated in 2010, 10 new sampling sites were added in 2011. These sites now include 14 AOCs of which 4 were new in 2011. Sampling sites include locations on all 5 Great Lakes and various connecting waterways and major tributaries. This is the most comprehensive data set available; it allows for comparisons across all sites sampled on the same species, something that has been lacking to date.

Focus Areas and FY 2013 Allocations

With FY 2013 allocations, and with the funds transferred under this IA, USGS will undertake actions in the focus areas below. The work being performed by USGS has timelines that are not severable because of the on-going nature of the work in each focus area. Most of the work that is described in the templates below relate to GLRI activities that were previously funded by a previous Interagency Agreements that were initiated in 2010 and 2012. The activities that USGS will undertake are set forth in this Scope of Work.

USGS Authority for Work

USGS authority to complete work under this project is pursuant to Public Law 99-591 that bestows permanent authority on the USGS to “prosecute projects in cooperation with other agencies, Federal, State, and private” (43 U.S.C. 36c), the USGS Organic Act of March 3, 1879, as amended (43 U.S.C. 31 *et seq.*), and the Water Resources Research Act of 1984 (42 USC 10303 (h)(1)(D))

USGS requests that the budget period for the FY2013 agreement be set to extend into FY2017. This period of performance allows for the completion of and expenditures on templates in the agreement some of which are non-severable.

2. BUDGET AND PROJECT DETAIL FOR FISCAL YEAR 2013

Focus Area	Project Title (template no.)	Page Number	Draft Allocation
TX	Determine Baseline and Sources of Toxic Contaminant Loadings (78)	7	\$572,235
TX	Mercury Cycling and Bioaccumulation in the Great Lakes (79)	9	\$154,063
TX	Birds as Indicators of Contaminant Exposure in the Great Lake (80)	11	\$484,200
TX	Sediment and Water Toxicity and the Status of Benthic Invertebrate Communities in the Rochester Embayment Area of Concern (146a)	14	\$70,000
TX	Quantifying Sediment and Nutrient Loading in the Genesee River as a criteria for BUI Delisting in the Rochester Embayment, and quantifying site best-practice implementation (146b)	18	\$125,000
TX	Riparian Indicators of Contaminant Exposure and Potential PCB Sources at Manistique River and Harbor AOC (146c)	21	\$212,499
TX	Determining Sources of Bacterial Contamination at Jeorse Park Beach (Phase I and II), in the Grand Calumet River AOC (146d)	23	\$91,000
TX	Development and Application of a Habitat Model for the Lower Maumee River AOC (146e)	26	\$350,000
TX	USGS Support for AOC Delisting (Decision Support for BUI removal) (384)	29	\$132,054
TX	Design and Planning Fish Habitat Remediation Projects in the St Clair and Detroit River Areas of Concern (401)	31	\$600,000
TX Total			\$2,791,051

IS	Invasive Phragmites – Prevention, Monitoring, and Control Strategies in an Integrated Pest Management Framework (67)	36	\$614,109
IS	Methods to Control Invasive Dreissenid Mussels (382)	40	\$650,000

IS	Asian Carp Control	43	\$650,000
IS Total			\$1,914,109

NS	Avian Botulism in Distressed Great Lakes Environments (73)	51	\$594,244
NS	Forecast/Nowcast Great Lakes Nutrient and Sediment Loadings (76)	54	\$528,217
NS	Enhance Recreational Water Quality Decision Making at Great Lake Beaches (77)	56	\$484,200
NS	Evaluation of Phosphorus Reduction in Targeted Geographic Watersheds – Fox River, Wisconsin (366)	58	\$145,000
NS	Evaluation of Phosphorus Reduction in Targeted Geographic Watersheds – Maumee River, Ohio (367)	60	\$145,000
NS	Evaluation of Phosphorus Reduction in Targeted Geographic Watersheds – Saginaw River, Michigan (368)	62	\$145,000
NS Total			\$2,041,661

H	Fish Habitat Enhancement Strategies for the Detroit River (70)	64	\$704,290
H	New Strategies for Restoring Coastal Wetland Function, Maumee River Area of Concern (71)	70	\$308,127
H	Restoration of Great Lakes Native Fish Community Resilience as a Buffer to Invasive Species Expansion (72)	75	\$336,298
H	Changes in Nutrient Transfer within Great Lakes Food Webs: Implications for Fish (74)	78	\$275,553
H Total			\$1,624,268

AEMECP	Watershed Modeling for Stream Ecosystem Management (81)	81	\$44,018
AEMECP	Characterizing Habitat and Food Web Structures across Great Lakes Estuaries (82)	83	\$220,090
AEMECP	USGS GLRI Database (84)	87	\$352,145
AEMECP	Quantifying Sediment and Nutrient	89	\$90,000

	Loading in the Massena, NY “Area Of Concern” and the St. Lawrence Connecting Channel as a Criteria for BUI Delisting (183c)		
AEMECP	Lake-Wide Management Plan Capacity Support by USGS (LaMP) (330)	92	\$331,896
AEMECP	Implementation of the Great Lakes Observing System (332)	95	\$352,145
AEMECP	Forecasting Great Lakes Basin Responses to Future Change (588)	98	\$176,072
AEMECP			\$1,566,366
Total			\$9,937,455

3. NARRATIVE SCOPES OF WORK FOR FISCAL YEAR 2013

Toxic Substances and Areas of Concern

Template 78 - Determine Baseline and Sources of Toxic Contaminant Loadings

Total funding: \$572,235

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The USGS contaminant and virus tributary monitoring network follows the National Monitoring Network for Coastal Waters design. The monitoring effort includes collecting emerging contaminant samples at 17 sites, a subset of the 30 nutrient monitoring sites (Template 76); and human viruses and other waterborne pathogen samples at 8 of these 17 sites; using automated, passive, surrogate, and manual sampling. This information will provide baseline information, provide support for measuring restoration progress, and provide potential load change information throughout the Great Lakes.

Because of the ongoing nature of this work, it is non-severable.

Milestones

At a subset of the 30 tributary monitoring sites, data on contaminants, viruses, and pathogens was collected beginning in the fall of 2010. In Year 4 of the GLRI, samples will continue to be collected at 17 sites for chemicals of emerging concern (PPCP - pharmaceuticals and personal care products). At 8 of the 17 sites, additional data will be collected for human viruses and other waterborne pathogens. These sites are a mix of land use including agricultural, urban and reference conditions. Ten of the sites are at AOCs. Frequency of sample collection will be reviewed in fall 2012 to determine if sampling can be reduced at some sites starting in Year 4.

Measures of Progress

1.2 Area of Concern Beneficial Use Impairments removed.

Monitoring of contaminants of emerging concern (PPCP - pharmaceuticals and personal care products) will help determine if programs to collect unwanted medicines are successful in decreasing the amount of these chemicals reaching the Great Lakes, and to provide baseline information for tracking potential future toxic contaminant threats. The virus sampling will provide a baseline for human and bovine viruses in tributaries and their potential impacts on human health. The monitoring will help determine if goals 2, 3, and 4 in Focus Area 1 are met.

Goal 2: The release of toxic substances in toxic amounts is prevented and the release of any or all persistent toxic substances (PTS) to the Great Lakes basin ecosystem is virtually eliminated.

Goal 3: Exposure to toxic substances from historically contaminated sources is significantly reduced through source reduction and other exposure reduction methods.

Goal 4: Environmental levels of toxic chemicals are reduced to the point that all restrictions on the consumption of Great Lakes fish can be lifted.

Collaborative Arrangements

Streamgages at all sites are supported by a variety of cooperative agreements. This effort will be coordinated with activities being conducted by the EPA, COE, FWS, States, and other monitoring entities.

Budget Information

Personnel	\$ 287,450
Fringe Benefits	\$ 76,174
Travel	\$ 5,000
Equipment	\$ 20,000
Supplies	\$ 5,000
Contracts	\$ 150,000
Indirect Costs	\$ 28,611
Total	\$ 572,235

Template 79 - Mercury Cycling and Bioaccumulation in the Great Lakes

Total funding: \$154,063

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The USGS will develop information on the internal (within lake) and external (watershed) sources of methylmercury, which is the form of mercury that bioaccumulates in fish and other aquatic organisms, for all five Great Lakes. In addition to source identification, this project quantifies methylmercury degradation mechanisms and rates to improve our understanding of controls spatial gradients across the Great Lakes. In the absence of this information, prescribing corrective measures for unsafe mercury levels in sport and commercial fish are very difficult to ascertain.

In FY 2013, the work funded by this template will focus on science synthesis from the two previous years of data collection, and to collaborate on the production of a numerical simulation model of mercury cycling (driven by sources and key processes) with an initial focus on Lakes Michigan and Superior. This model will serve as a robust tool to inform resource managers and decision makers on the most effective means for reducing methylmercury exposure and effects in Great Lakes food webs.

Milestones

1. Complete the sample analysis and data-base compilation for the Great Lakes tributaries/watershed loading component of this project. Next, extend the utility of this information by merging it with GIS layers that includes land-use and land-type information, such that we can derive a complete watershed loading estimate for mercury and methylmercury loads by watershed type.
2. Complete the sample analysis and data-base compilation for the Great Lakes proper component of this project. These data include the surface water, plankton, sediment, and benthos samples collected during the twice yearly sampling efforts across all five Great Lakes.
3. Provide a completed version of a process-based mercury cycling model for use by resource managers.
4. Publish a peer-reviewed journal paper on the outcomes of the “Mercury in the Great Lakes Mercury Workshop” (see Collaborative Arrangements below).

Measures of Progress

1.2 Area of Concern Beneficial Use Impairments removed.

Decisions about removal of mercury related fish consumption BUIs and delisting of AOCs will be supported by the information provided by work funded by this template. Goal 4 of Focus Area 1 – Environmental levels of toxic chemicals are reduced to the point that all restrictions on the consumption of Great Lakes fish can be lifted.

Collaborative Arrangements

Lake water column, sediment, plankton, and benthos samples have been obtained at about 80 sites across the Great Lakes in collaboration with USEPA's operation of the Lake Guardian. In addition, surface water runoff samples for mercury and methylmercury will be obtained in collaboration with work funded by templates 76, 78, and 81, which focus on tributary loads of toxics and pathogens.

On May 30 - 31, 2012 the USEPA and USGS co-hosted a "Mercury in the Great Lakes Mercury Workshop" to assemble for the first time, a complete representation of mercury science in the Great Lakes. Attended by about 50 multi-disciplinary scientists, this workshop brought together a scientifically complete assembly in an attempt to answer several key questions regarding mercury in the Great Lakes, such as:

- (1) what are the current spatial and temporal trends in mercury levels in all environmental compartments of the Great Lakes (air, precipitation, surface water, sediments, and biota);
- (2) do we have an adequate understanding of the sources of mercury and methylmercury such that we can explain significant changes Great Lakes conditions over the past decade;
- (3) what is the impact of invasive species on Great Lakes food web mercury levels;
- (4) have there been changes to water quality (e.g., nutrients, water clarity) that can help explain change in mercury levels; and,
- (5) can we anticipate the effects of climate change on Great Lakes mercury levels in the future?

Last, this project will seek to use novel field approaches (recently developed optical field sensors) to document the co-transport and delivery of mercury and methylmercury with natural dissolved organic matter (DOM) to near shore environments. These instruments will not only be useful for this project, but they will also be used for wetland restoration goals and will enhance our ability to predict future Great Lakes water quality should expansive wetland restoration in the basin proceed.

Budget Information

Personnel	\$ 109,225
Fringe Benefits	\$ 28,945
Travel	\$ 4,325
Equipment	\$
Supplies	\$ 3,865
Contracts	\$
Indirect Costs	\$ 7,703
Total	\$ 154,063

Template 80 - Birds as Indicators of Contaminant Exposure in the Great Lakes.

Total funding: \$484,200

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

Work supported under this project is quantifying exposure to, and effects of, both historical and emerging contaminants on Great Lakes food chains using sentinel indicator species such as colonial waterbirds and tree swallows. Results will contribute directly to assessments of Great Lakes ecosystem health and science-based decision making, provide data that will be directly used by States and EPA to assess whether specific BUIs can be removed and AOCs subsequently delisted, provide a baseline for future trend analysis, and determine the effectiveness of recent remediation actions at AOCs and other known hotspots.

The tree swallow data provide a biological matrix that is consistent across all AOCs and allow direct comparisons among AOCs and non-AOC locations across not only the Great Lakes, but also the northern tier of states in the U.S. as well as Canada. Because swallows can be enticed to nest at AOCs with the use of nest boxes, similar data will be available for all AOCs. Because there are effects thresholds already established for tree swallows, or other avian species, it can be determined directly whether exposures to contaminants of various chemical classes are at or above levels of concern. The collection of colonial waterbird data, where those species occur, in conjunction with the tree swallow data, will allow for modeling and assessment of possible contaminant effects throughout the aquatic ecosystem. The limited feeding radius of swallows and close ties to sediment contamination allow for an assessment of the biological availability of sediment contaminants as well as quantification of changes in sediment contamination that will be directly usable by EPA in remedy effectiveness assessments.

Milestones

Work to be completed during 2013 will build on work completed during the previous three years. Extensive baseline contaminant information was collected during 2010 to 2012 from across the Great Lakes for tree swallows as well as other colonial waterbirds. In addition to the 33 Great Lakes locations evaluated in 2010 and 2011, 11 new sampling sites were added in 2012 (Figure 1). These sites now include 20 AOCs of which 6 were new in 2012. Sampling at 3, and possibly 6, more AOCs will be instigated for 2013, likely including the St. Lawrence River, the Buffalo River and Eighteen Mile Creek. Sampling will also continue for a second year at AOCs initially sampled in 2012. Sampling sites include locations on all 5 Great Lakes and various connecting waterways and major tributaries. This is the most comprehensive avian data set available for the Great Lakes, which allows for comparisons across all sites sampled because the same species is being used.



Figure 1. Sampling sites in 2010 (red triangles), 2011 (green triangles), and 2012 (black triangles).

Effects endpoint information on tree swallows has been collected at 44 sites across the Great Lakes. At each active nest box at these sites, 14 independent measures of exposure and effects were quantified. Exposure data include both legacy contaminants (PCBs, dioxins/furans, pesticides, mercury), as well as new and emerging contaminants (PBDEs, PFCs). Effects data range from genetic damage endpoints to population-level effects on reproduction, which are important metrics in assessing two wildlife BUIs. This extensive range of effects endpoints covers numerous possible effects of many different classes of chemicals at many different levels of biological organization.

A web site established in 2011 for GLRI Project 80 provides access to preliminary results of this project (http://www.umesc.usgs.gov/wildlife_toxicology/glri_project80.html). These results are being updated frequently as new information becomes available, and currently include summary data on mercury, lead, other trace elements, biomarker results, and several organic contaminant classes. These data are immediately accessible to managers and regulators in a useful format. Results demonstrate patterns of contamination throughout the Great Lakes, and puts sites into context with one another. Sites are ranked to determine relative degree of contamination and are presented in mapped format for easy viewing and understanding. Data as presented can be used by State and Federal agencies to assess two wildlife BUIs.

Project 80 collected pre-remediation contaminant data at the following AOCs: Lincoln Park (Milwaukee Estuary), Hartshorn (= Division St. outfall into Muskegon Lake), River Raisin, Ottawa River (Maumee River AOC), Sheboygan River, Manistique, and Rouge River. Sampling at these AOCs following remediation will allow an assessment of remediation effectiveness.

Measures of Progress

Results will contribute directly to assessments of Great Lakes ecosystem health and science-based decision making, provide data that directly contribute to BUI removal and AOC delisting assessments, provide a baseline for future trend analysis, and determine the effectiveness of recent remediation actions at AOCs and other known hotspots. Specifically, the tree swallow and colonial waterbird data can be used directly by States and EPA to determine whether two BUIs – (1) Bird or Animal Deformities or Reproductive Problems and (2) Degradation of Fish and Wildlife Populations – can be removed. These data are being provided to States and EPA in a format and style that enable their immediate and efficient use. The tree swallow data can also be used in the remedy effectiveness context, directly and immediately, at those locations where remedies have already been implemented. Concentrations in tree swallow tissues are being measured pre- and post-dredging to assess remedy effectiveness for biological endpoints.

Collaborative Arrangements

Partners include FWS, EPA, NPS, NOAA, Canadian Wildlife Service, Great Lakes States, cities, universities, and various RAP coordinators and committees. Specifically, the Sheboygan, Green Bay/Fox River, and Menominee RAP groups (State of WI) have been using the tree swallow data as they move forward with their Stage 2 RAPs. The current tree swallow information was included in the draft BUI assessment prepared by the State of Michigan in 2012. The Waukegan Harbor CAC, IL and the St. Mary's River RAC, including the Bay Mills Indian tribe, have requested Project 80 to collect swallow data at their respective AOCs. Finally, requests have been received from the State of PA to collect tree swallow information at Presque Isle AOC. Project 80 is also collecting remedy effectiveness data, in close collaboration with EPA personnel at the Ottawa River, Muskegon Lake (Division St. Outfall), and Manistique River.

Budget Information

Personnel	\$ 107,114
Fringe Benefits	\$ 29,696
Travel	\$ 25,000
Equipment	\$
Supplies	\$ 16,000
*Contracts	\$ 282,180
Indirect Costs	\$ 24,210
Total	\$ 484,200

*Contracts include AXYS Analytical Services LTD for organic analysis (~240K) and Trace Element Research Laboratory for metal analysis (~42K)

Template 146a – Sediment and Water Toxicity and the Status of Benthic Invertebrate Communities in the Rochester Embayment Area of Concern — (Phase II)

Total funding: \$70,000

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of work

This proposal is for phase II of a 2-phase study started in FY 2012 with funding through the USGS-EPA FY 2012 IA. The study is being implemented in two phases due to logistical constraints and the need to incorporate methods developed (and findings) from a comparable investigations underway in the St. Lawrence/Massena AOC. The first phase of this study includes site selection, methods refinement, work-plan development, subcontract assembly, site reconnaissance, and sample (water, sediment, and benthic invertebrates) collection. The second phase, submitted here for the FY 2013 USGS-EPA IA, will be accomplished mainly during year 2 and consist of macroinvertebrate identification, water and sediment bioassays, data analysis and interpretation, and report preparation and review.

Bioassays will determine if local waters and sediment are toxic to two plankton species (*Selenastrum capricornutum* and *Ceriodaphnia dubia*) and to one or two species of benthic invertebrates (*Chironomus dilutus* and/or *Hyaella azteca*). In brief, we will generate water toxicity, bed-sediment toxicity, and benthic community data needed to test hypotheses that address various criteria for delisting BUIs for the degradation of (a) benthos and (b) phytoplankton and zooplankton populations. The first two hypotheses are that water and bed sediment from selected sample locations in the AOC are no more toxic to test species than is water and sediment collected from control sites outside the AOC. Acute (survival) and chronic (growth) toxicity tests will follow standard methods (USEPA 1994; USEPA 2000). The third hypothesis is that the benthic invertebrate communities from sites within the AOC are not significantly different, or are affected (impacted) no more seriously than the communities encountered at control sites according to spatial patterns in benthic community composition (nonparametric ordination) and the Biological Assessment Profile (BAP) index for Ponar samples collected from soft sediments, developed by NY State Department of Environmental Conservation (Bode et al. 2002; Smith et al. 2009). The component metrics that determine the BAP score include: SPP (species richness), HBI (Hilsenhoff Biotic Index), DOM3 (Dominance-3), PMA (Percent Model Affinity), and DIV (species diversity). The scores from the five indices are converted to a common 0-10 scale as shown in Figure 1:

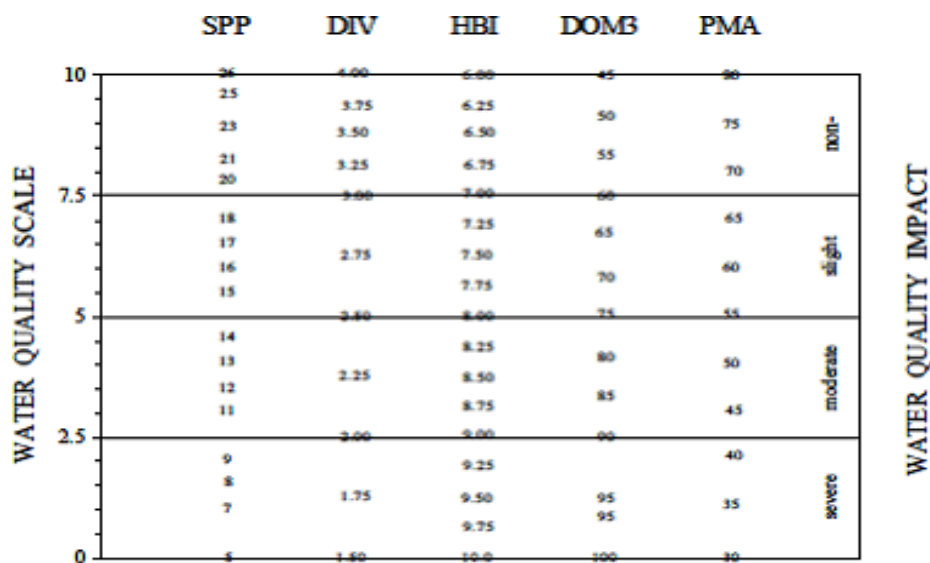


Figure 1. The Biological Assessment Profile for Ponar samples from soft sediments (Smith et al. 2009).

Water samples from river and lake sites will be obtained using a DC pump and inert tubing or a Van Dorn bottles where depths are greater than 20 m. A Petite Ponar sampler will be used to collect 5 replicate macroinvertebrate-community samples and a single composite sample for bed sediment toxicity tests at each study site. Larger sediments at offshore sites may not be suitable to toxicity tests and could require a full-size Ponar sampler for benthos (taxonomy) sampling. Bed-sediment size and organic content will be characterized by a NYSDEC subcontract laboratory using a split from the composite bed sediment-toxicity sample. Statistical analyses and multivariate (ordination) methods will be used to test the hypotheses and to determine if the bed sediments within the Rochester Embayment AOC meet any of the criteria for delisting the plankton or benthos BUIs. Because of the ongoing nature of this work, it is non-severable.

Milestones

A provisional timeline, which shows the estimated periods (or window of time) when task components are planned to be completed for both Phase-I (currently being conducted under USGS-EPA FY 2012 IA funding), and proposed Phase-II, is provided below.

Measures of Progress

1.2 Area of Concern Beneficial Use Impairments removed.

The main objective of this study is to determine if the plankton and benthos beneficial uses are currently impaired in parts of the Rochester Embayment AOC. Benthic invertebrate community, sediment toxicity, and water toxicity results will be used specifically to test whether water and bed sediments in the Rochester Embayment AOC meet established criteria for delisting either or both BUIs.

During two study phases (with some overlap), the USGS and NYSDEC propose to:

PHASE I

1. Generate a draft work plan, obtain stakeholder input, and modify the work plan based on

input.

2. Select target locations for water sampling, benthic-community surveys, and bed sediment collection.
3. Identify toxicity and taxonomic labs, request bids, assess bids, and select subcontractors.
4. Let contracts and finalize field sampling plan and logistics.
5. Reconnoiter study sites and evaluate accessibility, sampling procedures, and bottom bed sediments; finalize sampling sites.
6. Collect water samples three times at as many as 15 sites, and conduct plankton toxicity tests.
7. Collect benthic-community and sediment-toxicity samples from 15 to 30 study sites once during summer 2013.
8. Conduct 7-d growth, and 96-h survival and production bioassays with the plankton species, *S. capricornutum* and *C. dubia* following standard methods (USEPA, 2002b).
9. Conduct modified (20 d) acute (survival) and chronic (growth) bioassays (via subcontract) with *Chironomus dilutus* following standard methods (ASTM 2010; USEPA 1994; USEPA 2000) for sediment collected from each study site.

PHASE II

10. Process 100-organism (macroinvertebrate) subsamples from each Petite Ponar sample and identify specimens to the lowest possible taxon.
11. Verify and summarize benthic-community and toxicity data and test key hypotheses.
12. Assess results, assemble a draft USGS report (or paper), and obtain technical and editorial reviews.
13. Revise report/paper and publish as either a journal article or USGS report (on the web).

Collaborative arrangements

Field and laboratory work will be done in collaboration with the New York State Department of Environmental Conservation and all work will be coordinated with EPA Region 2 staff.

Budget Information

Personnel	\$ 47,817
Fringe Benefits	\$ 12,672
Travel	\$ 3,864
Equipment	\$
Supplies	\$ 2,147
Contracts	\$
Indirect Costs	\$ 3,500
Total	\$ 70,000

References

- ASTM. 2010. Standard E1706 - 05, 2010, Standard Test Method for Measuring the Toxicity of Sediment-Associated Contaminants with Freshwater Invertebrates. ASTM International, West Conshohocken, PA.
- Bode, R. W., M. A. Novak, L. E. Abele, D. L. Heitzman, and A. J. Smith. 2002. Quality Assurance Work Plan for Biological Stream Monitoring in New York State. N.Y. State Department of Environmental Conservation, Albany, New York.

- Smith, A. J., D. L. Heitzman, and B. T. Duffy. 2009. Standard Operating Procedure: Biological Monitoring of Surface Waters in New York State. New York State Department of Environmental Conservation NYSDEC SOP 208-09, Albany, NY.
- USEPA. 1994. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates. First Edition. US Environmental Protection Agency, Office of Research and Development, EPA/600/R-94/024, Duluth, MN.
- USEPA. 2000. Methods for measuring the toxicity and bioaccumulation of sediment associated contaminants with freshwater invertebrates. Second Edition. US Environmental Protection Agency, Office of Research and Development, EPA 600/R-99/064, Duluth, MN.
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Template 146b: Quantifying Sediment and Nutrient Loading in the Genesee River as a criteria for BUI Delisting in the Rochester Embayment, and quantifying EQUIP site best-practice-implementation

Total funding amount: \$125,000

Authority for work: USGS Organic Act, 43 USC 36c and General Cooperation Authority 43 U.S.C. 36c

Description of work

The Rochester Embayment Area of Concern (AOC) has a number of Beneficial Use Impairments (BUIs), specifically, number 11, Degradation of Aesthetics/sub-number 6 states: “Total suspended sediment (TSS) concentrations in the Genesee River remain less than 30 mg/l for at least 80% of a year, and exceed 200 mg/l for no more than 5 events with a combined duration of not greater than 20 days, as determined by a 5-year average (habitat delisting criterion on suspended sediment).” Similarly, number 8, Eutrophication or Undesirable Algae/sub-number 1 specifies: “Total Phosphorus (TP) concentrations for near (11-12 m) and near-near shore (1 m) are less than, or equal to, 15 ppb and 20 ppb respectively; and lists the monitoring method as “monitor total phosphorus concentrations from May through October in near and near-near shore areas.”

Additionally, towards this effort, the Natural Resources Conservation Service (NRCS) is currently assisting producers to implement management and structural conservation practices that will reduce sediment and nutrient loading into Lake Ontario through the Great Lakes Restoration Initiative (GLRI) and Environmental Quality Incentives Program (EQIP) program. NRCS in NY received funding in 2012 for EQIP, to contract with producers in the Genesee River priority watershed; however, NRCS currently does not conduct any stream monitoring before or after implementation of these conservation practices to assess their effectiveness in sediment or nutrient reduction.

Monitoring for TSS and TP would accomplish the primary goal of helping evaluate the BUI for delisting or for further action. Adding TP and soluble reactive phosphorous (SRP) to the monitoring would assess the usefulness of best-practice-implementation and provide a baseline for those projects slated to begin in the near future. Monitoring before, and after, best practices are implemented would provide valuable quantitative information on (1) the effectiveness of the practices and (2) loading of sediment and nutrients from smaller watersheds within the larger Genesee River basin. This information should then guide both the selection of most appropriate practices and also target sub-basins (smaller watersheds) that should be given priority for these practices to most effectively and efficiently utilize GLRI funds to meet the goal of sediment and nutrient reduction.

Sampling for TSS, turbidity, TP, SRP and habitat assessment will be conducted at 11 to 12 sites including:

- On the Genesee River above, at, and downstream from the Mt. Morris Dam (3 sites total)
- At two to three sites on the Genesee River near Rochester (3 sites total)
- At tributaries above the dam near: at least three sites at EQIP projects (3 sites total)

- At tributaries below the dam: at least three (3) sites at EQIP projects (3 sites total)

Final site selection will be based on the existing USGS gage network, NRCS EQIP sites, and Monroe County/volunteer organizations' familiarity, and will utilize EQIP sites that are within reasonable proximity of existing USGS gaging stations, provided that they are relevant to this project.

Monitoring would be conducted monthly and during at least three high-flow events by trained volunteers. A NYSDEC certified contract laboratory will perform the analyses for TSS, turbidity, TP and SRP. USGS and EPA will conduct seasonal, (or at least during one low- and one high-flow sampling period) concurrent sampling at selected sites to (1) establish and maintain appropriate QA/QC protocol and (2) provide a check on methodology used by non-federal participants. USGS and EPA will include in-situ parameters in their field measurements (pH, temperature, conductivity, and DO) as appropriate.

Milestones

A provisional timeline, which shows the estimated periods (or window of time) when task components are scheduled to be conducted on a monthly basis, is provided below.

Task	Year One												Year Two												Year Three											
Milestone	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
final EQUIP site selection	■																																			
contact and coordinate with volunteers	■	■																																		
volunteer sample collection training	■	■	■																																	
volunteers collect monthly samples				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
USGS quarterly QA/QC and flow measurements at EQUIP sites					■				■								■				■															
enter data into STORET and NWIS		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Work funded by this template will provide additional information needed to help EPA and NYSDEC make decisions to de-list the Rochester Embayment AOC degradation of aesthetics and phosphorous loading BUIs.

Measures of Progress

In general, the outcomes and outputs will include, but may not be limited to: data relevant to a valid TSS BUI delisting for the Rochester Embayment, monitoring data to support or improve EQIP projects, a larger data set of relevant parameters for the Genesee River and the watershed, a greater visibility for the volunteer monitoring organizations and their efforts, lessons learned, and transferability of the project design and implementation to other areas of the Great Lakes.

Additionally and specifically, these measures of progress will be addressed:

- 1.2 Area of Concern Beneficial Use Impairments removed
- 5.2 Number of priority LaMP projects that are completed.
- 3.1 Five year average annual loadings of soluble reactive phosphorus from tributaries draining targeted watersheds

This work will be essential to achieving a number of Great Lakes Restoration Action Plan objectives for Focus Area 3, Nearshore Health and Nonpoint Source Pollution, including:

- *By 2014, a baseline will be established for total suspended solids loadings from tributaries to the 'Genesee River'.* This work will collect the water-quality data needed to develop baseline total suspended solids loadings from sub-basins within the Genesee River basin.
- *By 2014, a measurable decrease will be achieved in soluble phosphorus loading from 2008 levels in targeted tributaries.* This work will develop a comprehensive characterization of soluble phosphorus loadings from which future reductions can be measured.

Also, in support of objectives for Focus Area 5: Accountability, Education, Monitoring, Evaluation, Communication, and Partnerships, including:

Goal 1. A cooperative monitoring and observing system provides a comprehensive assessment of the Great lakes ecosystem.

Objective 9: a comprehensive assessment of Great Lakes water resources that include monitoring and observing efforts.

Objective 10: provide timely data and information to decision makers

Collaborative arrangements

Laboratory analyses will be done in collaboration with the New York State Department of Environmental Conservation and all field data-collection will be coordinated with Monroe County Department of Health, EPA Region 2 staff and NRCS staff.

Budget Information

Personnel	\$ 64,759
Fringe Benefits	\$ 18,266
Travel	\$ 7,643
Equipment	\$ 22,500
Supplies	\$ 5,582
Contracts	\$
Indirect Costs	\$ 6,250
Total	\$ 125,000

Template 146c - Riparian indicators of contaminant exposure and potential PCB sources at Manistique River and Harbor AOC

Total funding: \$212,499

Authority for work: USGS Organic Act, 43 USC 36c and General Cooperation Authority 43 U.S.C. 36c

Description of Work

This work will investigate linkages between sediment PCB concentrations and subsequent exposure in riparian organisms living on land next to the river and harbor. This is an extension of prior work at the site that has been used by the Manistique River and Harbor Remediation Team (comprised of managers and scientists from USEPA GLNPO, USEPA ORD, NOAA, USACOE, USGS and the state of Michigan) to guide plans for delisting activities.

Riparian spiders are important mediators of contaminant flux from aquatic systems to nearby terrestrial habitats. Aquatic insects accumulate contaminants in their larval form, and transport these contaminants to terrestrial ecosystems in their adult bodies. Spiders are a key predator of aquatic insects, and many species feed almost exclusively on adult aquatic insects. Spider concentrations closely track ambient sediment concentrations, making them ideal indicators of ambient sediment concentrations and of ecosystem recovery from sediment remediation.

Traditional species for contaminant exposure studies such as tetragnathid (long-jawed spiders) and araneid (orb-weaving spiders) will be targeted for these studies.

This project will quantify contaminant exposure in riparian food webs at Manistique River and Harbor AOC. These data will be used to evaluate BUIs, to evaluate the relationship between sediment contamination and adverse biological exposures, and to identify areas that require additional source control and or active remediation efforts. Research will focus on 12 sites spanning the AOC, with emphasis on areas that have been identified as potential ongoing sources. The goal of this work is to inform development of a conceptual site model as well as a feasibility study and remedial design plan that it so be enacted in ~FY14.

Milestones/Schedule

1. Field crews ready and trained, supplies purchased, and contracts in place by March, 2013.
2. Field collections completed, sample databases prepared, samples shipped to chemical laboratories; June, 2013.
3. Data analysis, compilation, and summarization begins; August, 2013. GLNPO site manager preliminary briefing, August/September, 2013.
4. Data analysis, compilation, reporting and GLNPO site manager final briefing; December, 2013.

Measures of Progress

1.2 Area of Concern Beneficial Use Impairments removed

Supports Goal 1: AOCs are cleaned up, restoring areas and removing BUIs and Goal 3: Exposure to toxic substances from historically contaminated sources is significantly reduced through source reduction and other exposure reduction methods.

Specific BUIs addressed by this research are:

- 1) Degradation of benthos (riparian predators consume contaminated aquatic insects that originate in the benthos)
- 2) Restrictions on dredging (measurement of sediment PCB concentrations).

AOC managers can use data provided by these studies to:

- a) Help develop/refine conceptual site models and remedial designs for the AOC
 - b) Assess potential ongoing sources of PCBs to the AOC
 - c) Assess impact of future delisting activities
- 3) Establish that BUI removal criteria have been met

Collaborative Arrangements

US EPA (GLNPO and ORD) and other Federal, State, and Local agencies (e.g., NOAA and MI DNR) are collecting additional data on contaminant concentrations in water, sediment, and biota at this AOC. Specifically, US EPA ORD, USGS, and NOAA are collaborating on a larger study addressing sources/source control at this AOC. This riparian study will be integrated into this larger source tracking study in terms of experimental design, study execution, data analysis, interpretation, and reporting. This riparian study will also provide more extensive spatial and temporal exposure data throughout the AOC that can be used to broadly assess future delisting activities being planned for this site.

Budget Information

Personnel:	\$ 51,796
Benefits:	\$ 15,578
Travel:	\$ 14,500
Equipment:	\$
Supplies:	\$ 5,000
Contracts:	\$ 115,000
Other:	\$ --
Indirect Costs:	\$ 10,625
Total	\$ 212,499

Template 146d - Determining sources of bacterial contamination at Jeorse Park Beach (Phase I and II), in the Grand Calumet River AOC

Phase I (FY 2012) – Source Identification

Phase II (FY 2013) -- Current Modeling/Fate of Contamination

Total funding: \$91,000

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

Jeorse Park Beach is located in East Chicago, Indiana, within the Grand Calumet River Area of Concern (AOC), which has been identified as having all 14 beneficial use designations impaired, including beach closings. Jeorse Park Beach has been identified as one of the most highly contaminated beaches in the nation, with annual beach closings due to bacterial contamination as high as 76% in 2010. Further, beach closings have steadily increased each year since beach monitoring was initiated in 2005 in response to the Beaches Environmental and Coastal Health (BEACH) Act. Beach closings represent an environmental, social, and economic burden, the alleviation of which require various remediation strategies targeted to specific sources of microbiological contamination.

Research by USGS at Jeorse Park Beach in cooperation with the State of Indiana has identified dual factors contributing to beach closings: (1) the enclosed circulation of the beach area prevents contaminants from moving out of the embayment and (2) resident shore birds (geese, gulls) are a significant source of fecal contamination to the swimming water. In addition to bird contamination, evidence of human sewage contamination has also been found at this beach. The presence of additional sources of contamination, originating within or outside of the beach, and the influence of beach circulation patterns on retaining and influencing the persistence of these bacteria remain unknown.

Objectives and Scope – In this study, we propose to investigate the processes by which contamination is carried to the beach and retained. Work conducted in Phase I indicated potential sources of contamination, but an understanding of currents and their influence on contaminant advection and distribution is needed to determine restoration strategies and potential for success.

Relevance/Benefits – An improvement in water quality would directly benefit the Grand Calumet River AOC by helping to remove the impaired beneficial use designation of beach closings. The issues of beach closings, resident bird sources, and lack of circulation are common management issues, but without defined results, beach managers are unable to relate activities to reductions in bacterial contamination. With the results of this project, beach managers will have the necessary tools to pursue remediation of contaminants and therefore reduce the number of beach closings. Because of the frequency of the problem, results of this project could be transferred to benefit hundreds of beaches throughout the Great Lakes and coastal waters nationally. Benefits of a

reduction in beach closures include decreased human health risk, increased recreational access, and the promotion of economic opportunities.

Approach - A computational model for bacteria transport and fate from the source to nearshore water will be developed to assess the impact of Grand Calumet River, IN and Calumet River, IL on Jeorse Park beaches. This type of model is mechanistic, adapted from the widely applied Princeton Ocean Model and supplemented by a bacterial kinetics component. The same model has been applied to Chicago 63rd Street Beach and successfully identified major patterns of *E. coli* loading, deposition, and flushing characteristics in the embayed beach water. For Jeorse Park beaches, volume discharge and fecal indicator bacteria loading from either river will first be estimated. The computational model, using local bathymetry and current velocity at domain boundaries, will yield detailed spatial and temporal distributions of *E. coli* in the beach water. The model can be used to simulate a wide variety of hypothetical cases that may include impact of both rivers, and various weather and lake conditions.

Milestones

Results of this project will be reported to the AOC Care Committee, the RAP coordinator, and disseminated through other local and national scientific meetings, such as the Great Lakes Beach Association and the National Beach Conference, as well as in peer-reviewed scientific literature. Results will be of significant importance to beach managers throughout the Great Lakes and particularly to management agencies in AOC with beach closings as beneficial use impairment.

- Final Project Scoping with AOC Care Committee Winter and Spring 2013
- Model Development and Validation Spring and Summer 2013
- Integration of Phase I and Phase II findings and Analyses Summer and Fall 2013
- Final Report Submitted September 2013

Measures of Progress

1.2 Area of Concern Beneficial Use Impairments removed.

3.2 Percentage of beaches meeting bacteria standards 95% or more of beach days.

Work funded by this template will provide the information needed to remove the beach closing BUI at Jeorse Park Beach in the Grand Calumet River AOC. This project also directly supports the achievement of Measures of Progress 2 and 4 of Focus Area 3: Nearshore Health and Nonpoint Source Pollution as Defined in the Great Lakes Restoration Initiative Action Plan.

Collaborative Arrangements

The principal collaborators for this work are the AOC Care Committee for the Grand Calumet River Area of Concern, the State of Indiana, and East Chicago, Indiana.

Budget Information

Personnel	\$ 10,920
Fringe Benefits	\$ 2,730
Travel	\$ 1,450
Supplies	\$ 9,350
Contracts	\$ 62,000

Indirect Costs	\$ 4,550
Total	\$ 91,000

Template 146e - Development and Application of a Habitat Model for the Lower Maumee River AOC

Total funding: \$350,000

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

We propose to develop a hydro-geomorphic, spatial habitat model for the lower Maumee River and apply it to help resolve Beneficial Use Impairments (BUIs). The products will provide a detailed picture of river flows, lake nearshore and seiche dynamics, and river-lake mixing; and delineate aquatic habitats within the lower river. The approach is based largely on transfer of knowledge and techniques developed from the USGS Rivermouth Project, with:

- (1) larger scale given the size of the Maumee River,
- (2) greater resolution of flow patterns to quantify recently emphasized mixing processes that appear to be system drivers,
- (3) immediate application to an emerging issue: apparent high mortality of walleye larvae (and possibly other fish species) in the lower river through entombment in sediments, contaminant exposure, or predation in backwater habitats where larvae accumulate, and
- (4) evaluation of lower river habitats in terms of identifying restoration potential.

Lower-River mortality appears severe enough to impact year class strength of walleye, which support a multi-million dollar fishery in Lake Erie and an important spring fishery in the Maumee River proper. This work is applicable directly toward resolution of several BUIs:

- BUI 3, degradation of fish and wildlife populations;
- BUI 5, Bird or animal deformities or reproductive problems; and
- BUI 15, loss of fish and wildlife habitat.

A hydrodynamic habitat model is the key toward understanding mechanism underlying BUIs in that it will help resource managers track transport of a wide range of materials through the lower river and into Lake Erie's Western Basin, including: nutrients, bacteria, sediment, and fish larvae. These are assumed presently to be transported diffusely, but evidence from other river mouths suggests that substantial material concentration and processing occurs within this zone, with the added influence of lake-driven backflushing that results in flow reversals with lake materials re-entering the system; backflushing is more frequent and pervasive than generally recognized. This results in a wide range of biophysical outcomes with strong influence on water quality, availability of food resources for resident fishes, and overall habitat quality. In particular, mixing processes may have a strong influence on development of harmful algal blooms in Lake Erie.

First, we will develop a fine scale, temporal and spatial model of flows and mixing using flow data from stream gages and current profilers, information on lake dynamics, water-quality data including tracers and stable isotopes, and topographic/bathymetry information. Second, we suggest immediate application to the problem of walleye mortality using both field and laboratory approaches. Third, we will integrate our results to develop a more complete picture of the Maumee AOC within the Lake Erie ecosystem; prior work on inputs and stressors can be

linked to system outputs. And while important for the AOC directly, results will likely be useful downstream in western Lake Erie to better understand the river as a source for materials that contribute to long-standing issues of hypoxia and harmful algal blooms. We plan to disseminate our results rapidly and directly to AOC managers via directed workshops supported through an existing multi-agency rivermouth collaboratory and will coordinate as well with managers within the Lake Erie open-water ecosystem. There is also an opportunity to link the project to a USGS sponsored sediment initiative, and to coordinate with new studies of river-plume dynamics in western Lake Erie planned for 2013 - 2014.

Milestones

2013 Implement Rivermouth data collection of hydro-geomorphic information needed to develop the temporal/spatial habitat model inputs, and to apply this to studies of walleye fry mortality.

Begin development of habitat model.

Disseminate progress reports and potential applications to manager.

2014 Complete habitat model.

Work with managers to apply products to assist with AOC BUI delisting, and to understand lower river fish habitats in relation to walleye recruitment.

Measures of Progress

1.2 Area of Concern Beneficial Use Impairments removed.

Understanding rivermouth processes is essential in aiding managers with appropriate information for fish restoration efforts. This project is promoting implementation of the GLRI Great Lakes Action Plan as well as areas of increased emphasis on understanding of nearshore processes. Furthermore, results of this study may contribute to better understanding of the origin and possible prevention of harmful algal blooms (HAB's) in western Lake Erie. The project is divided into research (collecting requisite data specific to the Maumee River) and application (providing a habitat template to assist with AOC BUI delisting; and examination of walleye mortality using those data). Results will be important in examining material transport and processing, and the habitat model will serve as a tool to guide restoration by producing information for managers at a useful scale that was unavailable previously.

Focus Area 3: Nearshore Health and Nonpoint Source Pollution.

Focus Area 4: Habitat and Wildlife Protection and Restoration.

Goal 1: Protection and restoration of Great Lakes aquatic and terrestrial habitats, including physical, chemical, and biological processes and ecosystem functions, maintain or improve the conditions of native fish and wildlife.

Goal 3: Sound decision making is facilitated by accessible, site specific and landscape-scale baseline status and trend information about fish and wildlife resources and their habitats.

Measure 4. Will provide information for recovery action plans.

Collaborative Arrangements

Co investigators: Jeff Miner (Bowling Green State University), Kurt Kowalski (USGS Great Lakes Science Center), Jeff Schaeffer, (USGS Great Lakes Science Center), Lisa Fogarty (USGS water resources), Roy Kroll (Ducks Unlimited), Christine Mayer (University of Toledo), Patrick Kocovsky (USGS)

This study is a multi-agency endeavor that includes state, federal, regional, and local groups involved in the delisting process. These include: USEPA, US Fish and Wildlife Service. Ohio Department of Natural Resources, Ohio EPA, Toledo OH metropolitan council of governments, several local municipalities, and non-governmental organizations such as the Nature Conservancy.

This study is designed to interface directly with:

1. New study, Restoration of Rivermouth wetlands near Cullen Park (Ducks Unlimited and partners); and
2. Ongoing study, Characterizing habitat and food web structures across Great Lakes estuaries (USGS, will focus on Maumee food webs during FY 2013).

Budget Information

Personnel	\$ 40,560
Fringe benefits	\$ 11,940
Travel	\$ 20,000
Equipment	\$ 8,000
Supplies	\$ 2,000
Contracts	\$ 250,000
Indirect costs	\$ 17,500
Total	\$ 350,000

Template 384 - USGS support for AOC Delisting (Decision Support for BUI removal)

Total Funding: \$132,054

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

Areas of Concern (AOC) principles and guidelines were developed as an initial reference point from which appropriate restoration criteria could be developed. Stage 2 Remedial Action Plans (RAPs) were developed for each of these AOCs to address impairments to any one of 14 beneficial uses associated with these areas. Specific remediation actions are completed in order to restore the beneficial use. When monitoring data shows a beneficial use is no longer impaired, the state and EPA can remove that BUI. When data shows all identified beneficial use impairments have been eliminated, the EPA can submit a proposal to the International Joint Commission (IJC) for removing the designation of AOC in its entirety. Background information is available at these websites:

1. <http://www.ijc.org/rel/boards/annex2/buis.htm#table1#table1>
2. http://www.ijc.org/rel/boards/annex2/aoc_php/bui_targets.php?bui=Restrictions%20on%20Fish%20and%20Wildlife%20Consumption
3. http://www.ijc.org/rel/boards/annex2/aoc_php/
4. <http://epa.gov/glnpo/aoc/>

Specific information and measureable indicators are needed in order to demonstrate restoration of the beneficial use. The USGS will meet with State partners, and others, to develop a scientific framework to support decision needs specific to the AOCs, and when possible across multiple AOCs. This may include: determining appropriate measureable indicators, compilation of existing data and information, defining reference conditions, development of decision support framework, discussion of monitoring needed, etc.

The Beneficial Use Impairments (BUIs) where USGS will be most likely to be of help are: fish consumption advisories, fish tumor presence, eutrophication and unwanted algae, drinking water problems, beach health, and concentrations of PCBs in lake trout and walleyes. The other area that we can and are providing support is in assessing new toxic threats.

The initial focus (FY 2012 and 2013 funding) will be on fish consumption advisories and potential new threats associated with mercury contamination and associated processes.

Milestones

Meet with State and AOC coordinators and other partners to better understand the information needs related to BUI removal and develop ideas for support the USGS can provide.

Measures of Progress

1.2 Area of Concern Beneficial Use Impairments removed.

Collaborative Arrangements

USGS will work with State and local partners to develop the tools needed to support BUI delisting. Project will also leverage USGS GLRI database and internet mapping work associated with GLOS, database, and LaMP projects and data being collected in other USGS GLRI projects.

Budget Information

Personnel	\$ 99,754
Fringe Benefits	\$ 24,197
Travel	\$ 1,500
Equipment	\$
Supplies	\$
Contracts	\$
Indirect	\$ 6,603
Total	\$ 132,054

Template 401 – Design and Planning Fish Habitat Remediation Projects in the St Clair and Detroit River Areas of Concern

Total funding: \$600,000

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The purpose of this work is to develop scientifically sound, adaptive management strategies and management tools to restore high fishery productivity in the St. Clair and Detroit Rivers and to provide relevant up-to-date biological information to assist development of delisting criteria for the fish habitat loss Beneficial Use Impairment (BUI) 14. The design and planning work funded by this template aids in our understanding of the natural processes occurring in the system in order to best apply efforts aimed at restoring and enhancing native fish habitat and populations in the Huron-Erie Corridor through multi-agency/organization bi-national partnerships. Identifying, assessing, and prioritizing sites of natural fish spawning and nursery activity will provide essential information required for future fish spawning habitat construction and potential areas of fish nursery habitat restoration designed to address BUIs in the corridor and help define what constitutes adequate remediation in the AOC.

Loss of fish and wildlife habitat is BUI 14 in the St. Clair and Detroit River AOC. Since 2003, research monitoring and fish spawning habitat construction by the US Geological Survey, in collaboration with the Michigan Sea Grant and 15 other partners, has remediated loss of fish and wildlife habitat in the Detroit River, at Belle Isle (0.3 acres--see www.huron-erie.org and Manny 2006) and at Fighting Island (0.81 acres, see: <http://www.fws.gov/midwest/sturgeon/documents/4-19-08-PressRelease.pdf> and Roseman et al. 2011) at a combined cost of \$780,000 from US and Canadian sources. A third fish habitat remediation project by USGS and Michigan Sea Grant, funded by the NOAA Great Lakes Habitat Restoration Program, resulted in construction of 1.25 acres of fish spawning habitat in the Middle Channel of the St. Clair River during the summer of 2012, at a cost of \$1,053,000. These three fish spawning habitat remediation projects have increased spawning success of more than 12 native fish species in the Detroit River, including the State- and Provincially-threatened lake sturgeon, and the commercially-valuable lake whitefish and walleye that support fisheries in Lake Erie, worth over \$2 billion per year. The purpose and objectives of this research are compatible with the Strategic Vision for the U.S. Geological Survey in the Great Lakes-St. Lawrence Region (USGS 2000) and the National Fish Habitat Action Plan (www.fishhabitat.org).

In 2011, with \$100,000 of funding from the USEPA, the USGS modeled where water depth and water flow velocity are suitable for spawning by desirable native fish species, such as lake sturgeon, lake whitefish, and walleye, in the St. Clair and Detroit Rivers (see Bennion and Manny 2011a). This research revealed nine sites in the St. Clair and nine sites in the Detroit Rivers where water depth and flow are theoretically suitable for spawning by these three and other native fish species in these two rivers. Based on selected environmental criteria, the model assumed that these are the most suitable sites for successful spawning by native fish in the St.

Clair and Detroit Rivers. Our scientific assessments will measure the increase in fish production at the selected sites, as a result of this fish spawning habitat construction project. Concurrently, geospatial modeling will be conducted by D. Bennion and B. Manny to assess connectivity of St. Clair River fish spawning habitat site to fish nursery habitat in the St. Clair and Detroit Rivers, the St. Clair Delta, and Lake St. Clair.

The St. Clair River AOC Habitat Public Advisory Committee has identified the proposed actions as necessary to meet the Michigan Department of Environmental Quality delisting criteria for the removal of the loss of fish and wildlife habitat beneficial use impairment in the St. Clair River AOC.

Milestones

This template will support design and planning activities to remediate the loss of fish spawning habitat (BUI 14) at four sites in the St. Clair and Detroit River AOC. The funding will be used for planning, design, and permitting of two fish spawning habitat projects in the St. Clair River AOC in 2013; and for two sites planned for construction in the Detroit River AOC in 2014. The project construction sites were identified for further consideration by using geospatial, hydrodynamic and ecological process models of water velocity, water depth, and bottom substrates throughout the two rivers. Some of this funding will be used to assess physical and biological characteristics (reconnaissance) of the model-selected sites, prior to selection of final construction locations, preparation of engineering drawings, requesting construction permits and selecting construction contractors through a competitive bidding processes.

Since 2003, the USGS and its partners have acquired and made available comprehensive physical and biological information needed to restore native fish spawning habitat in the Huron-Erie Corridor between Lakes Huron and Erie (see www.huron-erie.org and Bennion and Manny 2011a), where reproductive habitat is a limiting factor in the restoration of native fish populations, as a result of shipping channel construction years ago (Bennion and Manny 2011b). Databases and information were collected and assembled on the spawning and nursery habitat used by native sport, commercial, prey fish, and state and federally listed species of concern so that scientists and resource managers can interpret relationships and interactions between physical habitat features (e.g. river bottom substrates, water depth, water temperature, and water flow rates) and the biological life history of native fishes.

Related projects at the GLSC supported the development of a bio-physical model to predict suitable sites for additional spawning habitat restoration in the Huron-Erie Corridor (HEC). This model coupled life history requirements of important benthic, lithophilic, spawning fishes (e.g. walleye, lake whitefish, lake sturgeon), with hydrologic attributes of the rivers to show where river depth and flow meet the requirements for spawning by these fish species. Model results demonstrate the importance of island heads and deep, main channels as potential fish spawning habitats in the St. Clair and Detroit Rivers. The GLSC also contributed data and samples to related projects that are assessing the genetic connectivity and divergence of lake sturgeon, walleye and yellow perch in the HEC, development and validation of a bio-physical model of walleye movement and habitat use in western Lake Erie, and stock identification of Lake Erie yellow perch, using micro-elemental signatures of otoliths.

Measures of Progress

This project is promoting implementation of the GLRI Great Lakes Action Plan, as well as Areas of Concern with increased emphasis by GLNPO for FY 2012-2014.

For example:

Great Lakes Action Plan

Focus Area 4: Habitat and Wildlife Protection and Restoration

Goal 1: Protection and restoration of Great Lakes aquatic and terrestrial habitats, including physical, chemical, and biological processes and ecosystem functions, and maintain or improve the conditions of native fish and wildlife.

Goal; 3: Sound decision making is facilitated by accessible, site specific and landscape-scale baseline status and trend information about fish and wildlife resources and their habitats.

Measure 6. This project will provide information for protecting wetlands that provide important nursery grounds for Great Lakes fishes along shorelines of islands and main channels in the Detroit and St. Clair Rivers.

Measure 9. This project is coordinated with the St. Clair River AOC Fish and Wildlife Restoration Plan and will lead to the removal of BUI 14, the loss fish and wildlife habitat, in St. Clair AOC and provide information about the abundance and distribution of invasive species in the Huron-Erie Corridor (HEC)

Collaborative Arrangements

USGS and Huron-Erie Corridor Initiative partners have developed scientific strategies, methods, and tools and, learning from previous habitat construction projects, and are adaptively improving techniques to address the loss of fish and wildlife habitat in the Huron-Erie Corridor (St. Clair and Detroit Rivers and Lake St. Clair). Partners include EPA, Michigan Sea Grant, USFWS, Michigan Department of Natural Resources, Detroit River International Wildlife Refuge, Ohio Department of Natural Resources, Tribal First Nations representation, Non-governmental Agencies, industry, and both provincial and Federal agencies in Canada.

This proposed design and planning project is building on an ongoing EPA-funded project to meet AOC delisting goals by developing a “blueprint” for fish habitat restoration in the HEC.

HEC scientists collaborated with researchers from The Ohio State University, Ohio Division of Wildlife, and Ontario Ministry of Natural Resources to develop and validate a bio-physical model for larval walleye in western Lake Erie.

HEC scientists collaborated with researchers from University of Toledo to assess the genetic connectivity and divergence of walleye and yellow perch collected in the HEC.

HEC scientists collaborated with scientists from the Ohio State University and the University of Windsor to assess the stock identification of yellow perch in western Lake Erie using otolith microchemistry.

HEC scientists collaborated with researchers from the Great Lakes Fishery Commission, Michigan DNR, and Ohio Division of Wildlife to develop and implement an acoustic telemetry array in the HEC to assess movements of walleye and lake sturgeon.

HEC scientists conducted field assessments of fish use of aquatic habitats near GLRI funded restoration projects in the Detroit River at Belle Isle-Blue Heron Lagoon, U.S. Steel shoreline, and fish spawning reefs constructed in the Middle Channel of the St. Clair River in 2012.

References

Bennion, D. and Manny, B.A. 2011a. Remediation of fish spawning habitat in the Huron-Erie Corridor (HEC). Submitted to J. Great Lakes Research.

Bennion, D. and Manny, B.A. 2011b. Construction of shipping channels in the Detroit River: History and Environmental Consequences. USGS Scientific Investigations Report 2011-5122.

Manny, B.A. 2006. Monitoring element of the Belle Isle/Detroit River Sturgeon Habitat Restoration, Monitoring, and Education Project. Research completion report to Michigan Sea Grant Program. University of Michigan. 401 E. Liberty, Suite 330, Ann Arbor, MI 34 pp. + tables, figures, and appendices.

Roseman, E.F., B.A. Manny, J. Boase, M Child, G. Kennedy, J. Craig, K. Soper, and R. Drouin. Lake sturgeon response to a spawning reef constructed in the Detroit River. *J. Appl. Ichthyol.* 27 (Suppl. 2) (2011), 66-76.

USGS 2002. Strategic vision for the U.S. Geological Survey in the Great Lakes-St. Lawrence Region, 2001-2010. USGS Open-File Report 02-193.

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Budget Information

Personnel	\$ 67,590
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Fringe benefits	\$ 17,910
Travel	\$ 20,000
Equipment	\$ 55,000
Supplies	\$ 25,000
Contracts	\$ 384,500
Indirect costs	\$ 30,000
Total	\$ 600,000

Invasive Species

Template 67 - Invasive *Phragmites* – Prevention, Monitoring, and Control Strategies in an Integrated Pest Management Framework

Total funding: \$614,109

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The invasive form of *Phragmites* is a well-established pest in many parts of the Great Lakes and the Atlantic, Gulf, and Pacific coasts, including Areas of Concern (AOC). It is currently managed using a suite of resource-intensive methods including manipulating water levels, applying herbicides, mowing/disking, and burning. Although new biological control options (i.e., insects) are being developed, conventional management tools being used now are unsustainable because of their time- and resource-intensive nature (i.e., expensive repeated applications are required). A similar situation exists for many other invasive plants (i.e., pests) across the nation, so new innovative control options that sustainably target the competitive advantage often enjoyed by invasive plants will contribute to a broad Integrated Pest Management (IPM) strategy. IPM involves a coordinated application of methods to minimize pest damage using the least hazardous and most efficient means possible. It involves examination of the pest and environmental conditions during the many phases of invasion or establishment (e.g., prevention, monitoring and mapping distribution, biology, best management practices, building partnerships among stakeholders, evaluating results of management strategies). This project targets the organisms that may help *Phragmites* spread and will employ a molecular genetic approach to silence the genes in *Phragmites* that allow it to reproduce and grow. Finally, this project focuses on the people side of *Phragmites* IPM, including building partnerships among stakeholders, evaluating results of control efforts, and feeding information back into the adaptive management process.

Phase 1 of the project (i.e., FY 2010 - 2012) was focused on developing sustainable invasive species control methods (i.e., targeting symbiosis with endophytic fungi, silencing genes that code for aggressive plant traits) that will promote the restoration and management of critical fish and wildlife habitats within the Great Lakes basin and across the nation. When considered in an IPM context, it was focusing on understanding the physical and biological factors affecting the number and distribution of *Phragmites* populations. It also was focused on identifying how *Phragmites* and other invasive plant species were interacting with their environments to gain a competitive advantage over native plants and exploring what chemical and biological processes may be targets for control. Innovative strategies have shown encouraging progress. Endophytic fungi were isolated in *Phragmites*, a new scientific discovery that now gives us a target for disrupting symbiotic relationships within the plants. In addition, preliminary field trials suggest that *Phragmites* appears to have sensitivity to fungicide. Similarly, our gene silencing work resulted in multiple sets of degenerative primers that were designed for genes associated with *Phragmites* photosynthesis, root development and reproduction. Several *Phragmites* genes and

delivery vectors are being tested in the Wayne State laboratory in preparation of field experiments into FY 2013. Most significantly, we have successfully silenced a photosynthesis gene (i.e., created an albino leaf) in maize as we transition the technology to *Phragmites*.

In to FY 2013 (i.e., Phase 2), we will use the early results of this project to emphasize how this work, for a relatively small investment, adds several new dimensions to the IPM strategy for *Phragmites* and other invasive plant species plaguing the nation. In addition to solidifying lab experiments and transitioning into wide-scale field trials, the project will be developing a new set of economically-viable tools and possible best management practices to reduce the risks associated with *Phragmites*, another core principle of IPM. Data for these tools will be drawn from the products and core efforts of the successful GLRI 68/75 *Phragmites* mapping and forecasting project and the collaborative communication framework (Great Lakes *Phragmites* Collaborative; <http://greatlakesphragmites.net/>) created in partnership with the Great Lakes Commission. In sum, the project will build on the developed capability to identify, monitor, and map current and potential pest distribution before new control strategies and/or the most effective conventional control strategies are implemented. The decision support system and other products produced by Phase 1 of this project will feed the developing Great Lakes *Phragmites* Collaborative to help provide information to decision makers and build partnerships that support focused and efficient application of management efforts. In order to align the project more closely with the emphasis on AOCs, the project will focus FY 2013 field trials on invasive species populations located in AOC and Priority Watersheds (e.g., River Raisin, Maumee River, Saginaw River/Bay, and Fox River). Similarly, communication with RAPs about study sites and IPM approaches will maximize the benefits to the BUI delisting process.

Milestones

Results of this project will be used to guide future proposals focused on potential implementation strategies for using successful techniques to control the invasive *Phragmites* haplotype M. Those experiments would include evaluation of collateral impacts on native species. Results also will promote information sharing, technology transfer, management efficiency, and collaborations among those focused on *Phragmites* in the Great Lakes basin. Specific milestones are as follows:

1. Create structure and initial content for Great Lakes *Phragmites* Collaborative web page, November 2012
2. Complete construction of transcriptome for *Phragmites* to identify target gene sequences for silencing, December 2012
3. Finalize a vector specifically for *Phragmites* and test it against other vectors, January 2013
4. Screening endophytes for fungicide sensitivity, March 2013
5. Test how invasive plants can be managed by killing endophytes using specifically designed solutions, April 2013
6. Explore regulatory hurdles for implementation of new control strategies, May 2013
7. Build out experiments to test endophyte-control and soil-restoration strategies at field sites located in AOCs, May 2013
8. Develop advanced content and tools for greatlakesphragmites.net based on recommendations of stakeholder steering committee, June 2013
9. Prepare for field experiments on gene silencing techniques at sites in AOC, June 2013

10. Communicate project results to the public and decision makers through presentations, web pages, fact sheets, and peer-reviewed manuscripts, September 2013

Measures of Progress

- 2.2 Acres managed for populations of invasive species controlled to a target level.
- 1.2 Area of Concern Beneficial Use Impairments removed.

Phragmites is an invasive plant that continues to spread throughout the Great Lakes and have negative impacts on coastal resources including critical fish and wildlife habitat and coastal views. *Phragmites* is also a major problem in most AOCs, so this project will benefit habitat restoration projects and other efforts to improve Beneficial Use Impairments (BUIs) in the Maumee River AOC, Saginaw River/Bay AOC, and many others. This project also addresses priority issues in the EPA directed Lakewide Management Plans for Lakes Huron and Erie, including restoring fish habitats, rehabilitation of nearshore habitats, reduce invasive species impacts, and protect island habitats.

Relevance to GLRI Action Plan

Focus Area 1: Toxic Substances and Areas of Concern

This project is focused on developing sustainable control measures for invasive plant species with a particular focus on the invasive *Phragmites australis*. *Phragmites* is well established in most AOCs and invasion often results in the degradation of aesthetics and loss of critical fish and wildlife habitat (identified impairments), so this project is addressing Long-Term Goal 1 (Areas of Concern are cleaned up, restoring the areas and removing the beneficial use impairments). If successful control measures are developed, they could be implemented in AOCs and support the removal of beneficial use impairments in AOCs across the basin. The Collaborative also will facilitate transfer of information and the consistent implementation of best management practices throughout the basin.

Focus Area 2: Invasive Species

Outputs and outcomes from this project could reduce the spread of invasive species beyond their current range (Long-Term Goal 3) by providing landowners and land managers new tools for managing and controlling invasive species before they become established. The project also contributes to an environmentally sound program of integrated pest management for invasive species (Long-Term Goal 5) by developing new measures to contain, eradicate, and control target species. More specifically, this project directly supports the “Principal Actions to Achieve Progress” by developing and demonstrating innovative control technology that could significantly reduce the cost and/or increase the effectiveness of species control measures.

Focus Area 4: Habitat and Wildlife Protection and Restoration

This project involves restoration of Great Lakes aquatic habitats by targeting invasive species control measures that will allow the restoration of wetland ecosystem functions and improvement of conditions for native fish and wildlife (Long-Term Goal 1). The project also supports Long-Term Goal 4 because the work is in line with the invasive species and other management priorities of the Lakewide Management Plans, resource management agencies (e.g., USFWS), the Nature Conservancy, and private resource managers.

Collaborative Arrangements

This work involves researchers and staff from the USGS – Great Lakes Science Center, Wayne State University, State University of New York – Brockport, Ducks Unlimited, The Great Lakes Commission, and many other partners.

Budget Information

Personnel	\$ 73,694
Fringe Benefits	\$ 18,423
Travel	\$ 10,000
Equipment	\$ 5,000
Supplies	\$
Contracts	\$ 476,287
Indirect Costs	\$ 30,705
Total	\$614,109

Template 382 - Methods to Control Invasive Dreissenid Mussels.

Total funding: \$650,000

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The invasive dreissenid mussels (zebra and quagga mussels) are negatively affecting the Great Lakes and other waterbodies throughout the Great Lakes Basin. Native species as well as recreational, municipal, industrial, and other water uses are adversely impacted by dreissenid mussels. Methods of detecting and monitoring, as well as physical, biological, and chemical methods of control are critical needs if managers are to respond rapidly to new and existing infestations. Research under this template would provide the basis for developing an integrated pest management (IPM) strategy to prevent further range expansion and to control existing invasive dreissenid mussel populations – research that will support the prevention and control of current and future Aquatic Invasive Species (AIS).

Research proposed for 2013 as part of this framework would examine several aspects of an IPM program to control dreissenid mussels. Understanding the invasion front and the extent of invasions is critical to any IPM program and research in this template would pursue developing eDNA markers to determine the presence/absence of dreissenid mussels and to differentiate their life stages. Development of these markers would enhance our ability to evaluate the efficacy of watercraft disinfection methods, detect new invasions and determine the effectiveness of treatments applied to infested water bodies.

Control of dreissenid mussels in currently invaded waters requires a multi-pronged approach as no one method would likely provide adequate control in every situation. Proposed research will evaluate the potential of low frequency electromagnetic (LFEM) radiation to control dreissenid mussels. Laboratory investigations by Purdue University observed increased mortality of zebra mussels following LFEM radiation exposure. The project would evaluate the effectiveness of LFEM radiation to control dreissenid mussels and assess potential non-target effects on native mussels. In addition, we would pursue development of effective chemical control tools for dreissenid mussels in the areas of spawning inhibition and species-specific delivery of mussel toxicants. Dreissenid mussel spawning may be inhibited by chemical cues released by the bluegreen algae *Microcystis aeruginosa*. Because dreissenid mussels occur at high densities and use broadcast spawning, cues that inhibit spawning coordination likely induce a chain reaction of chemical and physiological events that propagate throughout the population. Studies within this template would seek to identify and evaluate those cues as potential methods to disrupt dreissenid spawning. Work within the template would also apply knowledge gained in the development of methods to incorporate biocides into a targeted delivery system to control the invasive bighead and silver carps, in order to identify and incorporate mussel toxicants into targeted delivery formulations specifically for the control of dreissenid mussels. Using the peer-reviewed literature, we will identify toxicants with demonstrated activity to dreissenid mussels and with the highest likelihood of successful registration by EPA. Selected toxicants will be incorporated into delivery systems that take advantage of the unique characteristics of dreissenid

mussels feeding and digestion processes. Evaluation of potential toxicants will also include continued investigation of the effectiveness and potential non-target effects of biological control agents like the commercial product Zequanox® which contains killed cells of the bacterium *Psuedomonas fluorescens* strain Pf-CL145A.

Milestones

- Extract and isolate dreissenid spawning inhibitors released by algae (Q3 2013)
- Demonstrate in a laboratory that dreissenid mussel spawning is inhibited by one or more of the isolated chemical cues (Q4 2013)
- Acquire dreissenid mussel samples from Great Lakes and Europe and complete DNA extraction (Q3 2013)
- Next generation sequencing for SNP, eDNA, and probe development (Q3 2013)
- Microsatellite DNA analysis of samples to confirm that samples represent full range of variation and source of invasives and to determine if there has been any change in the genetic diversity and source(s) of dreissenids since previous analyses were performed (Q4 2013)
- Initiate ground-truthing of qPCR probes (Q4 2013)
- Complete mesocosm studies to assess the impact of LFEM on two non-target native mussel species and fathead minnows (Q4 2013)
- Identify candidate mussel toxicants for incorporation into a microparticle delivery system (Q1 2013)
- Complete development and testing of initial targeted delivery formulations using candidate mussel toxicants (Q4 2013).
- Complete invertebrate mesocosm exposures to assess potential non-target sensitivity (Q4 2013).
- Select field trial locations and begin bathymetric mapping and physical and eDNA surveys of zebra mussel populations to conduct field trials of potential toxicants (Q4 2013).

Measures of Progress

Results from the research described in this template will allow for early detection and rapid response for dreissenid mussel infestations, and will form the basis for an IPM program for eradication or control. A primer note describing fast and cost-effective qPCR protocol for screening water samples to test for presence of early life stages of dreissenid mussels will be developed. The protocol can be utilized to sample water throughout the country to quickly identify the presence of mussels in time to eradicate. Also, a microsatellite marker analysis will be completed providing updated information on lineages of dreissenid mussels present plus identification of potential sources will be developed. Progress in the development of control methods will be measured by

- (1) the identification and characterization of the chemical cues released by bluegreen algae that inhibit dreissenid mussel spawning behavior;
- (2) the completion of laboratory trials to determine the impacts of low-frequency electromagnetic radiation to non-target organisms, and
- (3) identification of 2 or more potential dreissenid mussel toxicants that can be incorporated into one or more microparticle delivery systems.

Collaborative Arrangements

Wayne State University, Department of Physiology: Conduct laboratory bioassays to determine the inhibitory character of fractions or components isolated from algae.

USGS-Leetown Science Center and Lake Erie Center, University of Toledo: next-generation sequencing for qPCR probe development, screening of water samples for presence of dreissenid DNA.

Budget Information

Personnel	\$ 201,700
Fringe Benefits	\$ 42,300
Travel	\$ 20,500
Equipment	\$ 54,000
Supplies	\$ 133,000
Contracts	\$ 166,000
Indirect Costs	\$ 32,500
Total	\$ 650,000

Template 673 - Asian Carp Control

Template Overview

This template includes activities associated with projects of the Asian Carp Control Strategy Framework.

Purpose

To contribute to the overall restoration of desired ecological conditions within the Great Lakes and to prevent the further expansion of Asian carps in the Great Lakes Basin.

To evaluate seismic technology to divert and eradicate Asian carps, to test carbon dioxide as another means of barrier control for Asian carps, and to communicate and demonstrate the value of new technologies for Asian Carp Control.

Project Title: Use of Seismic Technology to Divert and Eradicate Asian Carp (2.5.6)

Lead Agency: USGS (Upper Midwest Environmental Sciences Center [UMESC], Great Lakes Science Center, Illinois Water Science Center)

Other Agencies Involved: Illinois Department of Natural Resources (IL DNR), U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service, University of Illinois Urbana-Champaign, and Southern Illinois University

Total Funding: \$900,000 (USGS base – Great Lakes: \$400,000; GLRI: \$500,000).

Project Description

Silver carp and bighead carp, two invasive Asian carp species, have become established in the Mississippi River watershed, and there is potential for these fish to invade the Great Lakes waters in the near future. Currently, prevention of the movement of Asian carp from the Mississippi watershed into the Great Lakes rests on a set of electric barriers installed in the Chicago Sanitary and Ship Canal (CSSC). Additional barriers and/or supplements to the electric barrier would improve the efficacy of deterring Asian carp movement into the Great Lakes and elsewhere. Seismic technologies used in oil exploration create high pressure underwater sound energy waves that may deter the movement of Asian carp. These sound energy waves may be produced by a variety of means ranging from chemical explosives to high pressure air. Two pneumatic techniques, both involving high pressure air, are the air guns and water guns. Air guns release on command a specified volume of high-pressure air which produces a steep-fronted shock wave with several oscillations caused by the repeated collapse and expansion of the air bubble. Water guns use high pressure air to drive a shuttle through the lower chamber of the water gun. The rapid expulsion of the water in the lower chamber by the shuttle creates a void which is rapidly filled by the collapse of water back into the void – the collapse of water into this void creates a pulsed sound energy or pressure wave whose frequencies range from 20 to 1,500 Hz. Seismic technologies employed as a barrier could deter movement of or drive Asian carp

from an area, effectively supplementing existing barriers or by providing a standalone deterrent in other locations (e.g., locks, connecting waterways, etc.).

Prior to deploying seismic water guns in the CSSC to prevent movement of Asian carp past critical points, it is crucial that the effectiveness of this technology to either repel or damage carp in the field be demonstrated conclusively. Behavioral responses of several fish species to seismic surveys in marine environments suggest that seismic survey gear (e.g., air guns) cause increased fish movement (as evidenced by greater catch rates of marine fishes in gillnets [a gear which required fish to encounter it]) and decreased feeding (as evidenced by decreased catch using long line sets [a gear which requires active feeding] and decreased stomach contents). Movement response appears to vary with the habitat preference of the species - marine species using essentially featureless habitats were reported to have greater dispersal responses to seismic survey technologies than species that inhabit more specific “rough” bottom habitats. If freshwater pelagic species like bighead carp and silver carp respond similarly to marine pelagic fishes then the water gun discharge may cause them to disperse in response to the sound/pressure pulse generated from water gun discharge.

FY 2010-11 Actions Undertaken:

- The USGS conducted three separate experiments (Snake River cutthroat trout, Northern pike, and bighead and silver carp) evaluating use of water guns as a deterrent. Experiments assessed the feasibility of water gun deployment for use as a barrier and to determine acute and chronic lethal thresholds in fishes exposed to pulsed sound pressure levels. Studies were conducted in situ because the magnitude of water gun operations precludes completing them in a laboratory setting. In these studies, a water gun prototype (343-cubic-inch water gun) capable of generating 840 pounds per square inch (PSI) (254 decibels [dB] at 1 meter) was used in all experiments to maintain consistency. Initial studies demonstrated that the water gun can induce significant negative physiological effects in fish located within 9 meters from the sound source.

FY 2012 Actions Undertaken:

- The use of water guns to control, divert, and/or eradicate Asian carp was evaluated in experiments completed at Hansen Material Services, Morris, IL and in deployment to the electrical barrier on the CSSC. Experiments were intended to utilize metrics of fish movement to determine the feasibility of water guns for barrier applications and increased capture efficacy. Additional efforts were directed at water gun usage during electric barrier maintenance in conjunction with USACE, USCG, and IL DNR.

FY 2013 Actions Proposed:

- USGS will conduct a combination of controlled mesocosm experiments in the UMESC research pond complex and in field locations to evaluate pulse-pressure stimuli from 1 or 120 in³ water guns to exclude Asian carp from an area. Work in FY 2013 will focus on identifying the minimum gun size, operating pressure and gun discharge frequency needed to alter the behavior of Asian carp. Proposed behavior research will address current unknowns: (1) What is the optimal operating sequence and pulse pressure configuration to establish an acoustic barrier for both large and small carp? (2) For how long and at what distance will carp remain out of the area during and after the cessation

of pulse pressure application? (3) How will carp respond in different environments such as in the Chicago Sanitary and Ship Canal (CSSC) or around lock structures which would be considerably noisy due to anthropogenic activities, “masking” the acoustic noise created by the pulse pressure technologies? (4) Validation of the minimum gun size, operating pressure and gun discharge frequency needed to alter the behavior of carp under field conditions. Work completed in FY 2013 will evaluate the response of multiple sizes of Asian carp.

- Water gun operation in support of electrical barrier maintenance in the CSSC in conjunction with activities and requests of the USACE, U.S. Coast Guard, and IL DNR will be provided.

Expected end date: September 2014

If not completed after 2013, explain follow-up activities: Work would continue in 2014 to finalize the preparation of reports from the studies completed in 2013 and to transition the use of the water guns to management applications as dictated by the behavioral results determined during research in 2013. USGS would coordinate with management agencies that seek to implement water gun barriers to provide advice, guidance and training on barrier implementation and equipment operation.

Expected Milestones:

- Understanding of the minimum gun size, operating pressure and gun discharge frequency needed to alter the behavior of Asian carp.
- Recommendations on the minimum gun size, operating pressure and gun discharge frequency needed to create a static barrier to deter Asian carp.
- Recommendations on the minimum gun size, operating pressure and gun discharge frequency needed to create a mobile barrier/herding system to deter Asian carp.
- Recommendations on the minimum gun size, operating pressure and gun discharge frequency and implementation of those parameters during operations to support electrical barrier maintenance operations on the CSSC.

Potential Hurdles:

- The current configuration of the air compressor restricts operation to temperatures above 41°F (5°C). A mobile compressor configuration capable of placement onto a barge/boat is needed to allow operation in all weather conditions.
- A limited number of water guns are available and replacement parts are similarly in limited supply.

Budget Information

Personnel	\$ 212,037
Fringe Benefits	\$ 64,413
Travel	\$ 36,900
Equipment	\$ 111,650
Supplies	\$ 10,000
Contracts	\$ 40,000
Indirect Costs	\$ 25,000

Total	\$ 500,000
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Project Title: Field deployment of carbon dioxide barrier to deter Asian carp

Lead Agency: University of Illinois Urbana-Champaign

Other Agencies Involved: Illinois Department of Natural Resources; USGS (Upper Midwest Environmental Sciences Center)

Total Funding: \$100,000

Project Description

Previous work has demonstrated that carbon dioxide gas (CO₂), when applied to water, can cause significant behavioral, physical and physiological disturbances for Asian carp, including active avoidance. These results have significant benefits and application to act as a novel, fish barrier to supplement existing electric barriers with a redundant barrier technology. To date, evidence used to derive these conclusions have come largely from controlled, laboratory experiments performed under stable, 'ideal' circumstances. Therefore, despite the promise of CO₂ to act as a barrier to control the movement of Asian carp, a number of questions and uncertainties exist regarding its use in real-world scenarios, especially related to efficacy, feasibility, costs, and potential non-target impacts.

The overall goal of this project is to quantify the effectiveness and feasibility of using CO₂ gas as an Asian carp deterrent using ecologically-relevant scales in real-world scenarios. For this, the ecologically-relevant scale to be used would be an actual, full-sized lock on a waterbody currently used for commercial shipping. A full-scale CO₂ barrier at this lock chamber would be developed, implemented and tested. Quantification of barrier effectiveness would be carried out through the use of a telemetry array or remote monitoring (sonar, side-scan technology, etc.) of fishes currently residing downstream of the lock chamber. In addition, collaborations with agencies such as USACE, IL EPA and others would begin to quantify the impacts of target CO₂ concentrations on non-target organisms, as well as existing infrastructure.

FY 2010-11 Actions Undertaken: None

FY 2012 Actions Undertaken: None

FY 2013 Actions Proposed:

- USGS will conduct a combination of controlled mesocosm experiments in the UMESC research pond complex to confirm the utility of a CO₂ gas barrier to exclude Asian carp from an area. Work in FY 2013 will also focus on identifying potential water chemistry changes which might affect barrier application in navigational structures.
- Collaborate with UIUC and IL DNR to complete field evaluations of the utility of a CO₂ gas barrier to exclude Asian carp from an area.
- Assist to determine regulatory issues associated with emplacement of a CO₂ gas barrier to exclude Asian carp from an area.

Expected end date: September 2014

If not completed after 2013, explain follow-up activities: If successful trials are completed in FY 2013, additional work may be required to address any regulatory issues that may limit the deployment of this barrier system.

Expected Milestones:

- Improved understanding of the efficacy of CO₂ to act as a novel fish deterrent to prevent passage
- Improved understanding of the potential effectiveness of CO₂ to help facilitate directed movement of Asian carp to help with harvest efforts
- Knowledge of the cost, feasibility & logistic challenges associated with the use of CO₂ as a fish deterrent in a real-world scenario
- Assessment of the non-target impacts of CO₂ on biota, abiotic parameters, and existing infrastructure (i.e., existing cement locks)
- Journal publications and conference presentations on these findings to disseminate results and share outcomes with broader scientific community

Potential Hurdles:

- Extreme drought or flooding may limit the ability to complete field evaluations of a CO₂ gas barrier to exclude Asian carp from an area.

Budget Information

Personnel	\$ 35,213
Fringe Benefits	\$ 13,694
Travel	\$ 5,000
Equipment	\$ 25,093
Supplies	\$ 6,000
Contracts	\$ 10,000
Indirect Costs	\$ 5,000
Total	\$ 100,000

Project Title: Communication and Demonstration for new technologies for the Control and Monitoring of Asian carp

Lead Agency: U. S. Geological Survey

Other Agencies Involved: Illinois Department of Natural Resources, other agencies to be identified as technology and methodology development as appropriate

Total Funding: \$50,000

Project Description

As new control technologies have and will be developed to control and monitor the Asian carp, such as pheromones, food cues, and targeted oral-delivery platforms, results will need to be communicated to managers responsible for implementing the control technologies. The USGS will communicate these results through coordinating site visits at field-scale sites to demonstrate how technologies are applied and production of fact sheets and other publications to share new technologies with stakeholders and managers. Information will need to be presented in a straightforward manner and detail how to apply the new technology in a field setting. USGS will coordinate the communication approach across multiple projects to most efficiently demonstrate technologies and get the information to the stakeholders and managers. When possible, USGS will coordinate between multiple control technologies to show complementary capabilities. As technologies are demonstrated to be effective, eventually this project will move also into a training program to facilitate implementation of these control technologies. The long-term goal will to be develop field sites where multiple technologies can be evaluated over time, including developing infrastructure, where needed, at these field sites to support this mission.

FY 2010-11 Actions Undertaken: None

FY 2012 Actions Undertaken: None

FY 2013 Actions Proposed:

- Conduct conference calls to determine which projects have products ready to demonstrate and identify complementary control technologies.
- Arrange site visits for control managers and other partners to observe the control technologies being applied at USGS pond facilities.
- Draft and publish fact sheets or similar materials to disseminate to the stakeholders in the fight against Asian Carp

Expected end date: This project would continue as long as the Asian carp control technologies are being developed to ensure information was being delivered in a timely manner.

If not completed after 2013, explain follow-up activities:

Follow-up activities would include continuing to produce communication products for projects as new results are discovered, and developing a training program to help managers implement these control technologies.

Expected Milestones

- A list of projects with results to share (March 2013)
- Fact sheets drafted for selected projects (June 2013)
- Site visits arranged to see control technologies applied (Summer 2013)

Outcomes

- Quicker technology transfer from laboratory to field application.
- Managers being better informed about what control technologies are available for use.
- Possible implementation of control technologies that are more targeted toward elimination of Asian carp.

Potential Hurdles

Project schedule would be heavily dependent on the schedules of the projects developing the Asian carp controls.

Budget Information

Personnel	\$ 28,918
Fringe Benefits	\$ 13,582
Travel	\$ 5,000
Equipment	\$ --
Supplies	\$ --
Contracts	\$ --
Indirect Costs	\$ 2,500
Total	\$ 50,000

Nearshore Health and Nonpoint Source Pollution

Template 73 - Avian Botulism in Distressed Great Lakes Environments.

Total funding: \$594,244

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

Botulism intoxication is caused by ingestion of neurotoxins produced by the bacterium *Clostridium botulinum*. Periodic outbreaks of type E botulism have resulted in die-offs of fish and fish-eating birds in the Great Lakes since at least the 1960s, but outbreaks have become more common and widespread since 1999. Botulism has been responsible for over 100,000 bird deaths on the Great Lakes since 1999, and extensive bird mortality in northern Lake Michigan near Sleeping Bear Dunes National Lakeshore (SLBE; over 4150 birds in 2007) received widespread press attention and caused great public concern. The actual sites of toxin exposure for birds remain unknown.

Spores of *C. botulinum* are naturally widely distributed in the environment, but toxin production occurs only when suitable environmental conditions allow spore germination and cell growth, and this may be related to local soil and water conditions. The physical and ecological factors that are associated with toxin production, waterbird exposure, and botulism outbreaks are poorly understood in the Great Lakes, as in other environments. Invasive species, particularly dreissenid mussels *Dreissena spp.* and round gobies *Neogobius melanostomus*, have been implicated in the recent increased occurrence of botulism mortality in Great Lakes fish and birds, but this has not been proven. Dreissenid mussels may enhance nearshore algal growth, and decomposing algae may help create the anoxic conditions required for *C. botulinum* germination.

We hypothesize that recent increases in the incidence of type E avian botulism outbreaks in the Great Lakes may be associated with the presence of large amounts of decomposing sloughed *Cladophora*. We propose to determine the presence or absence of *C. botulinum* and type E botulinum toxin in sediments. In FY 2013, targeted sampling sites will be chosen in northern Lake Michigan near SLBE to represent sites that support varying amounts of sloughed *Cladophora* at a range of depths throughout the season. We further propose to use population surveys to assess waterbird distribution, with emphasis on species historically impacted by type E botulism (e.g., Common Loon *Gavia immer*), to examine the spatial relationships between bird distribution and carcass detection of confirmed botulism mortalities, and to analyze the relation between botulism in birds and environmental conditions at locations where toxin exposure is likely to occur.

Because of the ongoing nature of this work, it is non-severable.

Milestones

FY 2013: Aerial waterbird surveys of northern Lake Michigan will continue during fall 2012. Loon recapture efforts will continue during spring-summer 2013 to retrieve geolocator tags and archived movement and dive profile data. We will obtain estimates of force parameters operating on waterbird carcasses and incorporate these into a probabilistic source tracking model to estimate the origin of the bird carcasses, associated with type-E botulism mortality in Lake Michigan, that are deposited at a given beach location.

FY 2013: We will complete analysis of the distribution of the gene for botulinum toxin in lake sediments related to physicochemical variables for 2010 - 2012. Preliminary results suggest that the occurrence of the gene for the toxin is related to temperature. We plan to publish these results in 2013.

FY 2013: We will develop extraction and qPCR protocols for individual fish and analyze priority fish samples collected in 2011 and 2012. Continue analyses of sediments, mussels, cladophora for presence of the botulinum toxin gene using qPCR methods previously developed.

FY 2011: Developed a highly specific and sensitive *in vitro* assay, BoTest Matrix E, for detecting botulinum neurotoxin type E in avian blood. The assay also has utility for detecting botulinum neurotoxin type E in tissues from fish and invertebrates. Current research efforts are focused on producing additional antibodies to facilitate ongoing use of this new assay.

FY 2010 – 2012: USGS scientists have conducted several low-level, systematic aerial surveys (approximately 8,000 miles of transect surveyed during fall migration period in 2010 and 2011) over selected areas of northern Lake Michigan to document the fall distribution of waterbirds at-risk to type-E botulism. Results from these surveys are being used to inform site-specific efforts to assess the degree to which physical and ecological factors contribute to the occurrence of botulinum toxin in aquatic food webs.

FY 2010 – 2012: The fall movements and foraging patterns of a sentinel waterbird species at risk to botulism intoxication, the Common Loon, were documented by tracking migration movements coupled with foraging depth profiles of individual loons equipped with archival geolocator tags and/or satellite transmitters. Thirty-one loons were marked with both satellite transmitters and geolocator tags, and an additional 163 loons were marked with geolocator tags only. Eighty-five geolocator tags have been recovered from marked loons and many of these have provided dive profile data for loons while foraging in Lake Michigan; this is the first dive profile data collected for this species. Movements of radiomarked loons are posted on the UMESC public website and updated weekly. An understanding of feeding patterns and exposure routes of sentinel waterbird species historically at risk to botulism die-offs, such as the common loon, is central to assessing pathways of botulism exposure through aquatic food chains in the Great Lakes and identification of physical and biological linkages that drive botulism outbreaks.

FY 2011: Two publications:

LaFrancois, B.M., S.C. Riley, D.S. Blehert, and A. Ballmann. 2011. Links between type-E botulism outbreaks, lake levels, and surface water temperatures in Lake Michigan. *Journal of Great Lakes Research* 37: 86-91.

Piazza, T. M., D. S. Blehert, F. M. Dunning, B. M. Berlowski–Zier, F. N. Zeytin, M. D. Samuel, and W. C. Tucker. 2011. In vitro detection and quantification of botulinum neurotoxin type E activity in avian blood. *Appl. Env. Microbiol.* 77: 7815-7822.

Measures of Progress

3.4 Annual number of days U.S. Great Lakes beaches are closed or posted due to nuisance algae.
2.3 Number multi-agency plans established, mock exercises to practice rapid responses carried out under those plans, and/or actual rapid response actions.

The ultimate goal of this project is to develop management actions to reduce fish and bird mortality during botulism outbreaks. If, as we suspect, recent increases in botulism outbreaks are due to the presence of large amounts of decomposing algae, the presence of which is due to the effects of dreissenid mussels, then this will represent a reduction in the negative effects of dreissenids on fish and bird populations in the Great Lakes.

Applicable Goals, Objectives, and Measures from Great Lakes Action Plan:

Supports Focus Area 2: Invasive Species

Goal 5: An effective, efficient and environmentally sound program of integrated pest management for invasive species is developed and implemented, including program functions of containment, eradication, control, and mitigation.

Supports Focus Area 3: Nearshore Health and Nonpoint Source Pollution

Goal 3: The presence of bacteria, viruses, pathogens, nuisance growths of plants or animals, objectionable taste or odors, or other risks to human health are reduced to levels in which water quality standards are met and beneficial uses attained to protect human use and enjoyment of the nearshore areas.

Collaboration Arrangements

National Park Service, U. S. Fish and Wildlife Service, Wisconsin Department of Natural Resources, Minnesota Department of Natural Resources, University of Wisconsin – Madison, University of Wisconsin – Milwaukee, BioSentinel Pharmaceuticals, Common Coast Research and Conservation, The Nature Conservancy, Northeastern Wisconsin Audubon Society, Michigan Tech Research Institute, Northern Michigan University.

Budget Information

Personnel	\$ 195,000
Fringe Benefits	\$ 55,000
Travel	\$ 44,532
Equipment	\$ 90,000
Supplies	\$ 20,000
Contracts	\$ 160,000
Indirect Costs	\$ 29,712
Total	\$ 594,244

Template 76 - Forecast/Nowcast Great Lakes Nutrient and Sediment Loadings

Total funding: \$528,217

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The USGS nutrient tributary monitoring network follows the National Monitoring Network for Coastal Waters design. Scientists collect real-time, near-real-time, and synoptic flow and water-quality data (sediment and nutrients) from tributaries to the Great Lakes. The data provide baseline information to assess effectiveness of restoration and land management activities. Site-specific regression equations are being developed to relate selected laboratory-analyzed analyte concentrations in the discrete samples to measurements recorded by the water-quality monitors. This will enable near-continuous estimates of analytes and allow a reduction in laboratory samples, reducing costs while preserving temporal density of data. This work supports Great Lakes Lakewide Area Management Plans and Remedial Action Plans.

A methodology for providing uncertainty estimates on regression models of field measurements of water quality vs. hourly surrogate estimates of those water-quality parameters has been developed using Kalman filtering procedures. These filters will be used to estimate magnitudes and uncertainties of suspended-sediment concentrations and flows, which will help compute the expected magnitudes and uncertainties of loads of selected water-quality constituents at each site in the future.

Because of the ongoing nature of this work, it is non-severable.

Milestones

At 30 tributary monitoring sites, automated samplers, water quality multi-sensor probes, and gage house and stage equipment have been deployed. Water samples collected at the 30 tributary monitoring sites include suspended sediment; nutrients (incl. nitrogen, nitrite, nitrite + nitrate, total nitrogen, ortho-phosphorus (SRP), and total phosphorus); chloride, and bacteria. One sample per storm event is analyzed for major ions. At each site, monthly base flow samples are being collected, plus up to eight storms, with 6 samples submitted per storm (48 environmental samples per site/per year). In-situ water-quality sensors deployed at each site measure and record turbidity, temperature, conductivity, dissolved oxygen and pH every 15 minutes. As of September 1, 2012, 1,659 samples had been collected and analyzed for the suite of nutrients and suspended sediment, including quality assurance samples.

Measures of Progress

3.1 Five year average annual loadings of soluble reactive phosphorus from tributaries draining targeted watersheds.

Work funded by this template will directly contribute to measure 1 of the Nearshore and Non-Point Source Focus Area which is: “Five year average annual loadings of soluble reactive phosphorus¹⁸ from tributaries draining targeted watersheds.” Monitoring will provide a direct

measure of soluble reactive phosphorus concentration from the 30 tributaries, which include the priority watersheds of the Fox, Saginaw, Maumee, St. Louis, and Genesee Rivers. From this measure and the associated streamflow data, average annual loadings can be computed.

Collaborative Arrangements

Streamgage costs at all sites are supported by a variety of cooperative agreements.

Budget Information

Personnel	\$ 218,677
Fringe Benefits	\$ 58,129
Travel	\$ 20,000
Equipment	\$ 55,000
Supplies	\$
Contracts	\$ 150,000
Indirect Costs	\$ 26,411
Total	\$ 528,217

Template 77 - Enhance Recreational Water Quality Decision Making at Great Lake Beaches

Total funding: \$484,200

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

USGS will improve and refine existing beach predictive models, rapid methods, and the identification of sources of fecal contamination, pathogens, and viruses at beaches in the Great Lakes in order to improve beach managers decision-making.

This funding would be used enhance existing efforts to advance the science of monitoring and assessing recreational water quality to provide beach managers with reliable, science-based information to make well-informed beach closure decisions to protect public health focusing on:

- Identifying and evaluating new or rapid methods to improve monitoring of bacteria at beaches.
- Identifying physical and biological processes that influence the occurrence and abundance of key bacteria and pathogens that pose risks to recreational users of beaches and nearshore waters.
- Enhancing existing models and expanding models to additional beaches to improve forecasts of water quality and support more timely and effective public health warnings, advisories, and beach closures.
- Improving communication of monitoring and scientific information and developing tools to enhance response of beach managers to changing beach and water quality.

Because of the ongoing nature of this work, it is non-severable.

Milestones

- Implement and provide the training rapid method use at 4 beaches.
- Continue the analysis and interpretation of the over 350 pathogen samples collected in FY 2011.
- Continue the collaboration with USEPA to integrate new statistical techniques into the next version of Virtual Beach as well as distribute data compilation and web service tools to allow beach modelers to access spatially processed meteorological, hydrodynamic, and other environmental data.
- Continue the development of predictive models at 8 beaches in Ohio, 6 beaches in Pennsylvania, and 10 beaches in Wisconsin for implementation of nowcast modeling in FY 2013.

Measures of Progress

3.2 Percentage of beaches meeting bacteria standards 95% or more of beach days.

3.4 Annual number of days U.S. Great Lakes beaches are closed or posted due to nuisance algae.

This project directly supports the achievement of Measures of Progress 2 and 4 of Focus Area 3:

Nearshore Health and Nonpoint Source Pollution as Defined In the Great Lakes Restoration Initiative Action Plan.

Collaborative Arrangements

This work is being coordinated closely with USEPA and NOAA efforts through the Great Lakes Beach Health Interagency Coordination Team. In addition a number of individual state and local agencies are directly involved with efforts on the over 50 beaches that are part of the coordinated effort to date.

Budget Information

Personnel	\$ 301,000
Fringe Benefits	\$ 74,200
Travel	\$ 44,790
Equipment	\$ 40,000
Contracts	\$
Indirect Costs	\$ 24,210
Total	\$ 484,200

Template 366 - Evaluation of Phosphorus Reduction in Targeted Geographic Watersheds – Fox River, Wisconsin

Total funding: \$145,000

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The Great Lakes Restoration Initiative (GLRI) was established to accelerate ecosystem restoration in the Great Lakes by confronting the most serious threats to the region, such as nonpoint source pollution, toxic sediments, and invasive species. Three Priority Watersheds have been targeted by the Regional Working Group's Phosphorus Reduction Work Group (Fox/Green Bay, Saginaw, and Maumee) and are characterized by having a high density of agricultural land use and have ecosystem impairments that have been clearly identified.

Within the Fox River Priority Watershed, monitoring is being conducted at the sub-watershed and edge-of-field scale. The edge-of-field stations are targeted to those areas within each watershed that will be directly affected by the conservation efforts. These sites will allow for a rapid assessment of conservation implementation as the water quality from those locations are immediately affected by land-use and management changes and represent the major pathways for non-point pollution to enter the stream. Relationships between the smaller to sub-watershed scale will help develop an understanding on how conservation efforts may impact the watershed as a whole.

Because of the ongoing nature of this work, it is non-severable.

Milestones

The sub-watershed and one of the two edge-of-field stations have been selected and instrumented. Automated samplers, gage houses, and stage and power equipment has been placed at the monitoring locations. The final edge-of-field station location has been determined and will be established by November 2012. Water samples collected at all the sites will be analyzed for suspended sediment, chloride, nitrate+nitrite, ammonium, total kjedahl nitrogen (unfiltered), reactive phosphorus, and total phosphorus (unfiltered after Water Year 2012 (October 2011 to September 2012), there were 19 composite samples submitted for the one edge-of-field site and 53 storm samples submitted for the sub-watershed location, as well as 9 baseflow samples.

Measures of Progress

3.1 Five year average annual loadings of soluble reactive phosphorus from tributaries draining targeted watersheds.

Monitoring at the priority watershed scale will provide a direct measure of the effects of USDA conservation practice implementations on reducing erosion and nutrients by targeting those areas affected by the conservation practice. This study will also provide data to verify the five year

average annual loading targets of soluble reactive phosphorus as described in the Great Lakes Action Plan.

Collaborative Arrangements

Site selection, maintenance, and on-farm information are being collected in cooperation with the local Brown County U.S.D.A. Natural Resource Conservation Service, Brown County Land and Water Conservation Department, local crop consultants, and private landowners/producers.

Budget Information

Personnel	\$ 74,030
Fringe Benefits	\$ 19,620
Travel	\$ 2,000
Equipment	\$ 21,800
Supplies	\$
Contracts (incl. lab)	\$ 20,300
Indirect Costs	\$ 7,250
Total	\$ 145,000

Template 367 - Evaluation of Phosphorus Reduction in Targeted Geographic Watersheds – Maumee River, Ohio

Total funding: \$145,000

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The Great Lakes Restoration Initiative (GLRI) was established to accelerate ecosystem restoration in the Great Lakes by confronting the most serious threats to the region, such as nonpoint source pollution, toxic sediments, and invasive species. Three Priority Watersheds have been targeted by the Regional Working Group's Phosphorus Reduction Work Group (Fox/Green Bay, Saginaw, and Maumee) and are characterized by having a high density of agricultural land use and have ecosystem impairments that have been clearly identified.

Within the Maumee River Priority Watersheds, monitoring is being conducted at the sub-watershed, edge-of-field, and subsurface-tile scale. The edge-of-field and subsurface-tile monitoring stations are targeted to those areas within each watershed that will be directly affected by the conservation efforts. These sites will allow for a rapid assessment of conservation implementation as the water quality from those locations are immediately affected by land-use and management changes and represent the major pathways for non-point pollution to enter the stream. Relationships between the smaller to sub-watershed scale will help develop an understanding on how conservation efforts may impact the watershed as a whole.

Because of the ongoing nature of this work, it is non-severable.

Milestones

The sub-watershed, edge-of-field, and subsurface tile monitoring locations have been selected and instrumented in August 2012. Automated samplers, gage houses, and stage and power equipment have been placed at the monitoring locations. The sub-watershed location was placed at an existing USGS streamgage (04188496 Eagle Creek above Findlay, OH) and additional equipment was placed to allow for automated sampling. The edge-of-field and subsurface tile are located within the same basin, allowing for a comparison of water quality results from both surface and subsurface water flow paths. Water samples will be collected at all the sites and will be analyzed for suspended sediment, chloride, nitrate+nitrite, ammonium, total kjedlahl nitrogen (unfiltered), reactive phosphorus, and total phosphorus (unfiltered). After Water Year 2012 (October 2011 to September 2012) there were 2 composite samples submitted at the edge-of-field site, 2 composite and 2 discrete samples submitted at the subsurface tile, and 19 discrete storm and 1 baseflow sample submitted for the sub-watershed location.

Measures of Progress

3.1 Five year average annual loadings of soluble reactive phosphorus from tributaries draining targeted watersheds.

Monitoring at the priority watershed scale will provide a direct measure of the effects of USDA conservation practice implementations on reducing erosion and nutrients by targeting those areas affected by the conservation practice. This study will also provide data to verify the five year average annual loading targets of soluble reactive phosphorus as described in the Great Lakes Action Plan.

Collaborative Arrangements

Site selection, maintenance, and on-farm information are being collected in cooperation with the local U.S.D.A. Natural Resource Conservation Service, Ohio Department of Natural Resources, U.S.D.A. Agricultural Research Service, Ohio State University, Heidelberg University, Blanchard River Watershed Group, local crop consultants, and private landowners/producers.

Budget Information

Personnel	\$ 68,998
Fringe Benefits	\$ 20,332
Travel	\$ 2,000
Equipment	\$ 21,800
Supplies	\$
Contracts	\$ 24,620
Indirect Costs	\$ 7,250
Total	\$ 145,000

Template 368 - Evaluation of Phosphorus Reduction in Targeted Geographic Watersheds – Saginaw River, Michigan

Total funding: \$145,000

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The Great Lakes Restoration Initiative (GLRI) was established to accelerate ecosystem restoration in the Great Lakes by confronting the most serious threats to the region, such as nonpoint source pollution, toxic sediments, and invasive species. Three Priority Watersheds have been targeted by the Regional Working Group's Phosphorus Reduction Work Group (Fox/Green Bay, Saginaw, and Maumee) and are characterized by having a high density of agricultural land use and have ecosystem impairments that have been clearly identified.

Within the Saginaw River Priority Watersheds, monitoring will be conducted at the sub-watershed, edge-of-field, and subsurface-tile scale. The edge-of-field and subsurface-tile monitoring stations will be targeted to those areas within each watershed that will be directly affected by the conservation efforts. These sites will allow for a rapid assessment of conservation implementation as the water quality from those locations are immediately affected by land-use and management changes and represent the major pathways for non-point pollution to enter the stream. Relationships between the smaller to sub-watershed scale will help develop an understanding on how conservation efforts may impact the watershed as a whole.

Because of the ongoing nature of this work, it is non-severable.

Milestones

The sub-watershed, edge-of-field, and subsurface tile monitoring locations have been selected and instrumented in April 2012. Automated samplers, gage houses, and stage and power equipment have been placed at the monitoring. The edge-of-field and subsurface tile are located within the same basin, allowing for a comparison of water quality results from both surface and subsurface-water flow paths. Water samples will be collected at all the sites and will be analyzed for suspended sediment, chloride, nitrate+nitrite, ammonium, total kjedahl nitrogen (unfiltered), reactive phosphorus, and total phosphorus (unfiltered). After Water Year 2012 (October 2011 to September 2012) 7 discrete samples were submitted at the edge-of-field location and 11 discrete and 3 composite samples were submitted at the subsurface tile. The sub-watershed had 18 discrete storm samples submitted, as well as 6 baseflow samples.

Measures of Progress

3.1 Five year average annual loadings of soluble reactive phosphorus from tributaries draining targeted watersheds.

Monitoring at the priority watershed scale will provide a direct measure of the effects of USDA conservation practice implementations on reducing erosion and nutrients by targeting those areas affected by the conservation practice. This study will also provide data to verify the five year

average annual loading targets of soluble reactive phosphorus as described in the Great Lakes Action Plan.

Collaborative Arrangements

Site selection, maintenance, and on-farm information are being collected in cooperation with the local U.S.D.A. Natural Resource Conservation Service, local crop consultants, and private landowners/producers.

Budget Information

Personnel	\$ 70,678
Fringe Benefits	\$ 20,892
Travel	\$ 2,000
Equipment	\$ 21,800
Contracts (incl. lab)	\$ 22,380
Indirect Costs	\$ 7,250
Total	\$ 145,000

Habitat and Wildlife Protection and Restoration

Template 70 - Fish Habitat Enhancement Strategies for the Detroit River

Total funding: \$704,290

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The purpose of this work is to develop science-based adaptive management strategies and management tools to restore high fishery productivity in the Detroit River and to provide relevant up-to-date biological information to assist development of delisting criteria for fish habitat loss Beneficial Use Impairments (BUI). The work funded by this template aids in our understanding of the natural processes occurring in the system in order to best apply efforts aimed at restoring and enhancing native fish habitat and populations in the Huron-Erie Corridor through multi-agency/organization bi-national partnerships. Identifying, assessing, and prioritizing sites of natural fish spawning and nursery activity will provide essential information required for future fish spawning habitat construction and fish nursery habitat restoration designed to address BUIs in the Detroit River Area of Concern (AOC) and help define what constitutes adequate remediation in the AOC.

In FY 2013, laboratory sample processing and field collections will be conducted to continue development of decision support systems for managers using geospatial, hydrodynamic and ecological process models to determine the optimal areas for restoring fish spawning and nursery habitats. Managers will use the information provided to determine the proper course of action required for protecting, enhancing, or restoring existing native spawning habitat or creating new fish spawning (e.g. Manny 2006; Roseman et al. 2011) and/or nursery habitat in areas that meet criteria for fish life history stages (preferred substrate for spawning and flow connectivity to downstream nursery areas). Field collections in FY 2013 will focus on fish spawning and nursery habitat assessments in the Detroit River to provide new data for the model efforts described above, provide pre- and post-construction assessment information for other GLRI funded projects (e.g. Blue Heron Lagoon, Belle Isle wetland and South fishing pier, U.S. Steel shoreline restoration), and provide fisheries assessment information at the Fort Wayne reef construction site (funded by National Fish and Wildlife Foundation), Belle Isle, and Fighting Island (funded by ON MNR, ERCA, COA) spawning reefs.

Integrating geospatial and hydrodynamic models with ecological fisheries data will estimate natural habitat attributes (geomorphology, flow regimes, depths, substrate characteristics, and bank slope) that provide baseline parameters for fish habitat remediation activities. Ecological process models will couple physical and biological fish habitat parameters and further identify potential priority sites where productive fish spawning habitats are linked with suitable nursery habitats. Data collected will be applied to models estimating larval fish production and contributions of HEC stocks to Lake Erie populations (e.g. yellow perch - Brodnik et al. In prep.;

walleye - Chen et al. In prep.; walleye - Zhao et al. 2009; GLFC-funded project to S. Ludsin, Ohio State Univ.; molecular genetics, C. Stepien, Univ. Toledo and W. Stott USGS-GLSC). In addition, ecological models will provide information regarding the effects of high nutrient loads and harmful algal blooms on fish survival in nursery grounds. These applied science efforts will provide new knowledge about the linkages between fish spawning and nursery habitat which is used to direct restoration activities (e.g. replace lost spawning habitat; manage recovering populations; Roseman et al. 2012). Ultimately, the degree of success in restoring fish populations is measured by the percent of young fish produced in enhanced habitats that are recruited into reproductive adult fish populations.

Planning and organization for the HEC Conservation Action Plan (CAP) status assessment and development began in FY 2012 and continues in 2013. The CAP is intended to make use of contemporary data and knowledge that describe the status of the ecosystem in efforts to derive conservation targets and priorities, identify key habitats and ecological units, and reveal knowledge gaps. The CAP process will build upon existing partnerships in the HEC and make use of data and information collected in previous years of Template 70 as well as from other science agencies and organizations. In addition to these efforts in the HEC, USGS scientists collaborated with the Nature Conservancy in the Lake Erie CAP (2011 - 2012) that is under development (<http://www.slideshare.net/OhioEnviroCouncil/lake-erie-biodiversity-planning-forum>).

Because of the ongoing nature of this work, it is non-severable.

Milestones

Acquire and make available comprehensive physical and biological information necessary to characterize and/or restore existing native fish spawning and nursery habitat in the HEC where reproductive habitat is a limiting factor in the restoration of native fish populations. Databases and information were collected and assembled on the spawning and nursery habitat use by native sport, commercial, prey fish, and state and federally listed species of concern so that scientists and resource managers can interpret relationships and interactions between physical habitat features (e.g. substrate, flow, water temperature) and biological life history of fishes; December 2011.

Completed three years of intensive field sampling to assess the extent of fish use of existing spawning and nursery habitats. Over 10,000 samples of fish eggs and larvae were collected at sites throughout the Detroit River and across a multitude of habitat types. Laboratory and statistical analyses of collected samples (e.g. identification of larvae, diet assessments, micro-elemental assessment of stock lineage, genetic analyses, multivariate analyses, and bio-physical modeling) are ongoing in FY 2013 and FY 2014.

This project supported and collaborated with the USEPA in the development of a bio-physical model to predict suitable sites for additional spawning habitat restoration in the HEC (Bennion and Manny, in review). This model coupled life history requirements of important lithophilic spawning fishes (e.g. walleye, lake whitefish, lake sturgeon), with hydrologic attributes of the rivers to show where river depth and flow meet the requirements for fish spawning. Model results demonstrate the importance of island heads and main channel fringe habitats as potential

spawning habitats. These model results are being used by the EPA to set fish spawning habitat related BUI delisting requirements for the St. Clair and Detroit rivers, and helped advise the siting of the “Fort Wayne” fish spawning reef proposed for the Detroit River.

This project (Template 70) contributed data and samples to projects assessing the genetic connectivity and divergence of walleye and yellow perch in the HEC, development and validation of a bio-physical model of walleye movement and habitat use in western Lake Erie, stock identification of Lake Erie yellow perch using otolith micro-elemental signatures (cited above), and spawning success of lake sturgeon in the Detroit River (collaborative project funded by USGS Science Support Program with USFWS and MI Technological University).

Physical habitat characterization efforts began during the summer 2012 field season and will continue through at least the 2013 field season. Side-scan sonar imagery and underwater video data were collected at multiple sites identified in the Bennion and Manny bio-physical model as high potential for restoration efforts. A total of 71 sonar transects were run at 1 site in the Detroit River (Ft. Wayne) and 4 sites in the St. Clair River (Port Huron, St. Clair, Algonac, and the mid-channel delta). These transects totaled over 106 km in length, covered over 722 ha of channel bottom, and consist of over 8.7 GB of data. In addition to the sonar data, over 70 underwater video drift transects were conducted representing approximately 9 hours of underwater video. Laboratory post-processing of the data will begin in October as we continue field data collection efforts. Substrate classification maps of the sites will be available for the portions surveyed by late winter 2013. As field data collections continue, the substrate classifications maps will be modified and expanded and used to inform site selection for Template 379.

Measures of Progress

4.3 Number of species delisted due to recovery.

4.4 Percent of recovery actions implemented for priority listed species.

4.5 Percent of populations of native aquatic non-threatened and endangered species self-sustaining in the wild.

4.9 Number of habitat-related Beneficial Use Impairments removed from the 27 U.S. Areas of Concern.

This project is promoting implementation of the GLRI Great Lakes Action Plan as well as areas of increased emphasis by GLNPO for FY 2012 and 2013.

Great Lakes Action Plan

Focus Area 4: Habitat and Wildlife Protection and Restoration.

Goal 1: Protection and restoration of Great Lakes aquatic and terrestrial habitats, including physical, chemical, and biological processes and ecosystem functions, maintain or improve the conditions of native fish and wildlife.

Goal 3: Sound decision making is facilitated by accessible, site specific and landscape-scale baseline status and trend information about fish and wildlife resources and their habitats.

Measure 6. Will provide information for protecting wetlands that provide important nursery grounds for Great Lakes fishes.

Measure 9. Will aid in removal of BUIs in the Detroit River.

Collaborative Arrangements

Data collected during 2010 - 2012 as part of GLRI Project Template 70, as well as data collected by GLSC and HEC partners in previous years, were used to inform the development of the predictive habitat model (Bennion and Manny, in review) that is the basis for GLRI Project Template 379: Remediation of Fish and Wildlife Habitat in the St. Clair River AOC. While GLRI Project Template 70 will focus on laboratory analyses, model development, and field collections in the Detroit River, and the emphasis for Project Template 379 is spawning habitat in the St. Clair River, many of the same scientists will continue to be involved in both projects during FY 2012 and beyond. Physical habitat data collected using side-scan sonar and underwater video during 2012-2013 as part of GLRI Project Template 70 will be used to supplement and enhance the modeling effort undertaken by Bennion and Manny to establish candidate sites for fish habitat restoration activities and to inform site selection for project 379.

Field crews working on habitat classification data collection activities hosted a day on the Detroit River to 5 foreign exchange students visiting Eastern Michigan University from Huazhong Agricultural University (HZAU) in Wuhan, China, to observe habitat mapping efforts related to fish restoration projects in the St. Clair - Detroit River System. The five undergrad and graduate students are from the College of Fisheries at HZAU, and are the second cohort of an exchange program between the Biology Department at Eastern Michigan University and HZAU. Every summer, 4-5 biology students from EMU visit HZAU for 3.5 weeks to participate in graduate student research of their partner students at HZAU in the fields of fisheries science, freshwater ecology or plant molecular biology and to study Chinese language and culture. In return, the HZAU partner students visit EMU the same summer for 3.5 weeks to participate in ongoing research, learn about freshwater research in our region and improve their English. As part of their time in Michigan, the students got an opportunity to join the Great Lakes Science Center's researchers and participate in side-scan sonar mapping, and underwater video assessment of the substrates and fish activity within the Detroit River.

GLSC scientists will sponsor and mentor two summer interns as part of DOI's Office of Youth Partnerships & Service AmeriCorps Summer Internship Program. The interns will gain valuable field and laboratory experience working with Project 70 scientists to assess fish spawning and nursery habitats, with an emphasis on larval lake sturgeon production.

USGS and Huron-Erie Corridor Initiative partners have developed scientific strategies, methods, and tools and, learning from two previous habitat construction projects, are adaptively improving techniques to address the BUI loss of fish spawning habitat in the Huron-Erie Corridor. Partners include USFWS, EPA, Michigan Department of Natural Resources, Ohio Department of Natural Resources, Tribal representation, non-governmental agencies, industry, and both provincial and Federal agencies from Canada. This part of the project is building on an ongoing EPA-funded project to meet AOC delisting goals by developing a “blueprint” for fish habitat restoration in the HEC.

USGS scientists organized and participated in numerous outreach and communication programs during 2012 to highlight ongoing research and key results. Working with outreach specialists from MI Sea Grant, USGS scientists helped prepare a video demonstrating the successful spawning by lake sturgeon on a newly constructed spawning reef in the St. Clair River (example: <http://gallery.usgs.gov/videos/543>). USGS and Sea Grant staff also organized and carried out a celebration of science (<http://www.ns.umich.edu/new/multimedia/videos/20385-construction-of-new-rock-spawning-reefs-will-help-great-lakes-native-fish>) and a boat tour of the HEC and media event held in Algonac, MI for USGS, GLRI, EPA, state, and local administrators, to demonstrate and discuss ongoing research and restoration programs in the HEC (example: <http://www.thetimesherald.com/article/20120829/NEWS01/308290012/Man-made-reef-aids-spawning-fish>).

GLSC scientists continue collaborations with researchers from The Ohio State University, Ohio Division of Wildlife, and Ontario Ministry of Natural Resources to develop and validate a bio-physical model for western Lake Erie larval walleye. Continued assessments of fish spawning and larval production in the Detroit River during FY 2013 and FY 2014 are needed to facilitate collaborative population and habitat modeling efforts (lake sturgeon parentage and conservation genetics [A. Welsh, West Virginia Univ.], Lake Erie Bio-physical models [S. Ludsin et al., Ohio State Univ.]; larval production [C. Mayer and M. DuFour, Univ. Toledo], post construction spawning habitat use; genetics [C. Stepien, Univ. Toledo]; lake sturgeon ecology and larval production [N. Auer, MI Technological Univ.])

GLSC scientists collaborated with researchers from University of Toledo to assess the genetic connectivity and divergence of walleye and yellow perch collected in the Detroit River (Haponski and Stepien, In press; Sullivan and Stepien, In press). Results of these analyses show a need for larger sample sizes to better represent Detroit River spawning stocks.

GLSC scientists collaborated with USFWS and GLFC scientists to develop a sampling program for sea lamprey transformers in the lower Detroit River during fall and winter 2012. This work is being expanded in 2013 and GLSC staff will assist with field collections, sample processing, and data analyses.

GLSC scientists collaborated with scientists from The Ohio State University and University of Windsor to assess the stock identification of yellow perch in western Lake Erie using otolith microchemistry (Brodnik et al. in prep.). Additional samples of water and larval fishes will be collected from the Detroit River during FY 13 to augment this study.

GLSC scientists collaborated with researchers from the Great Lakes Fishery Commission, Michigan DNR, and Ohio Division of Wildlife to develop and implement an acoustic telemetry array in the HEC to assess movements of walleye and lake sturgeon (<http://www.glfc.org/telemetry/>).

GLSC scientists conducted field assessments of fish use of aquatic habitats near GLRI-funded restoration projects in the Detroit River at Belle Isle Blue Heron Lagoon, Belle Isle South fishing pier and nursery habitat, and U.S. Steel shoreline enhancement, and fish spawning reef construction at the Middle Channel of the St. Clair River (MI Sea Grant).

GLSC scientists at Ann Arbor and Sandusky are collaborating with scientists from Ontario MNR and Ohio DNR to explore the long-term interjurisdictional bottom trawl data series to assess the contributions of fishes from the HEC and Lake Huron to Lake Erie populations. Trawl data from western Lake Erie will be compared with historic (Hatcher et al. 1991) and contemporary larval fish data collected from the HEC to assess relationships in abundances and distributions within the data.

This project was coordinated with work being done by the U.S. Geological Survey under a separate Interagency Agreement for \$100,000 that is related the Coordinated Science and Monitoring Initiative (CSMI) work for the Connecting Channels. This Agreement was signed on December 31, 2009.

Budget Information

Personnel	\$ 167,650
Fringe benefits	\$ 44,425
Travel	\$ 60,000
Equipment	\$ 40,000
Supplies	\$ 10,000
Contracts	\$ 347,000
Indirect costs	\$ 35,215
Total	\$ 704,290

Template 71 - New Strategies for Restoring Coastal Wetland Function, Maumee River Area of Concern

Total funding: \$308,127

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

USGS will focus on restoring natural hydrologic processes in diked coastal wetlands adjacent to Great Lakes waters to improve wetland functions like phosphorus retention and restoration of habitats for fish and wildlife. Sustainable approaches are being developed in the Maumee River Area of Concern (AOC) to restore the hydrology and other processes that drive coastal wetland functions and increase ecosystem resiliency. Results will be evaluated within an adaptive management framework and integrated with similar sites in the Saginaw River/Bay AOC and throughout the Great Lakes basin.

The purposes of the project are to:

- hydrologically reconnect a diked wetland to Lake Erie to restore coastal wetland function and native species habitats,
- implement a short- and long-term monitoring program to characterize response of biotic and abiotic ecosystem elements, especially those relating to Beneficial Use Impairments (e.g., phosphorus retention) after restoration actions, and
- communicate project results to researchers, managers, policy makers, and the general public to ensure that outcomes of the project can:
 - 1) guide future management and restoration efforts in western Lake Erie and throughout the Great Lakes basin,
 - 2) contribute to landscape-level efforts to improve ecosystem resiliency to stressors, and
 - 3) support implementation of sustainable and adaptive management strategies.

Since the connection to the wetland was restored, the abundance and diversity of fish using the wetland habitats has exploded. Northern pike and other recreationally and commercially valued species are again using the 40 ha wetland for reproduction and feeding. Bird usage by waterfowl and several listed species is extensive. Preliminary water-quality data indicate that the water exiting the wetland back into the Maumee River AOC had significantly less phosphorus and other nutrients than the incoming water, which has very positive implications for the water quality BUI for the Maumee River AOC. Additional samples taken through FY 2013 will characterize the spatial and temporal patterns of fish use, nutrient retention, and other important wetland processes. Coordinated efforts with the coastal wetland monitoring program, data collection efforts identified in Remedial Action Plans, NOAA-funded habitat restoration projects, and The Nature Conservancy to help guide regional restoration strategies and maximize basin-wide impact of locally-important projects.

Because of the ongoing nature of this work, it is non-severable.

Milestones

Water-quality and biota sampling will continue in FY 2013 to characterize spatial and temporal patterns within restored wetland habitats and share that information with regional managers and partner agencies leading similar restoration projects.

1. Completed intensive data collection and monitoring for first season before reconnection of wetland habitats, November 2010
2. USGS, FWS, and Ducks Unlimited worked together to design, build, and open a water-control structure on April 2011, thus reconnecting 40 ha of wetland to Lake Erie
3. Intensive sampling of fish, birds, plants, benthic invertebrates and physical conditions on the Ottawa National Wildlife Refuge characterized ecosystem response during the first full growing season after the management action (December 2011)
4. Intensive sampling commenced in April 2012 to quantify ecosystem changes during the second growing season in the restored wetland and ecosystem response will again be characterized fully after the second growing season (December 2012)
5. Water quality, fish assemblages, mussel use, and other AOC Beneficial Use Impairment-related data were analyzed and communicated to resource managers and policy makers directly after Year 1 sampling (February 2012) and will be again after Year 2 sampling (January 2013)
6. Results of analyses will be integrated with other data collection efforts in western Lake Erie and Saginaw River/Bay AOC to develop regional strategies for restoring and adaptively managing isolated coastal wetland habitats.
7. Fact sheets and presentations about the project will be developed for educational purposes at Ottawa National Wildlife Refuge, Shiawassee National Wildlife Refuge, and at other venues, September 2013

Measures of Progress

4.2 Number of fish passage barriers removed or bypassed.

4.6 Number of acres of wetlands and wetland-associated uplands protected, restored and enhanced

4.8 Percent of U.S. coastal Great Lakes wetlands assessed.

4.9 Number of habitat-related Beneficial Use Impairments removed from the 27 U.S. Areas Of Concern so impaired.

1.2 Area of Concern Beneficial Use Impairments removed

This project is promoting implementation of the GLRI Great Lakes Action Plan as well as areas of increased emphasis by GLNPO for FY 2012 and FY 2013.

Relevance to GLRI Action Plan and other priorities

Focus Area 1: Toxic Substances and Areas of Concern

This project is focused on the USFWS Ottawa National Wildlife Refuge located in the heart of the Maumee River AOC and the Shiawassee National Wildlife Refuge located just upstream from the Saginaw River/Bay AOC (Long-Term Goal 1). Outputs and outcomes of the project are restoring coastal wetland habitats and providing data that support the removal of beneficial use impairments in the AOCs (one of the objectives of this Focus Area).

Focus Area 4: Habitat and Wildlife Protection and Restoration

This project involves restoration of Great Lakes aquatic habitats through the restoration of wetland ecosystem functions and improvement of conditions for native fish and wildlife (Long-Term Goal 1). The project also supports Long-term Goal 2 by restoring access of fish species to previously isolated habitats and conserving important fish and wildlife populations (i.e., northern pike, Lake Erie and Saginaw Bay prey fish, native mussels). The intensive data collections associated with this project supports Long-Term Goal 3 by providing status and trend information to resource managers, especially how they respond to restoration actions. Goals 4 and 5 also are supported because the work is in line with the priorities of the Lake Erie LaMP and is very sensitive to and compatible with fish and wildlife and their habitats. Finally, the project includes many of the Principal Actions identified in the GLRI Action Plan; 1) *Improving Aquatic Ecosystem Resiliency* through restoring natural hydrological processes, 2) *Enhance Wetland Habitats* through restoration of natural hydrological regimes, improving water quality, and restoring ecosystem integrity, 3) *Identify, Inventory, and Track Progress on Great Lakes Habitats, Including Coastal Wetlands Restoration* through our multi-year intensive data collection strategy, and 4) *Restore Habitat Functioning in Areas of Concern* by removing impairments that limit ecosystem functioning.

Focus Area 5: Accountability, Education, Monitoring, Evaluation, Communication, and Partnerships

This project supports many of the Long-Term Goals identified in the Action Plan through the efforts to communicate results to the public, managers, and decision makers through personal discussions, presentations, fact sheets, web pages, and other forms.

Lakewide Management Plans

Similar to the AOC beneficial use impairments, this project will collect data on fish, plant, and wildlife assemblages, phosphorus concentrations, and other water-quality parameters that will contribute to the delisting process associated with the beneficial use impairments identified by IJC in the Lake Erie LaMP. Specifically, the project should address the following BUIs: Degraded Fish and Wildlife Populations, Degradation of Benthos, Eutrophication or Undesirable Algae, Recreational Water Quality Impairment, and Loss of Fish and Wildlife Habitat.

Other GLRI Projects

GLRI 70 – Fish Habitat Enhancement Strategies for the Huron-Erie Corridor

- The study site is located within the Huron-Erie Corridor, and linkages between connecting channel habitats and restored coastal wetlands are being explored.

GLRI 80 – Birds as Indicators of Contaminant Exposure in the Great Lakes

- Cooperation between projects led to the selection of the Ottawa NWR as a study site for GLRI 80.

GLRI 79 – Mercury Cycling and Bioaccumulation in the Great Lakes

- Discussions with Dave Krabbenhoft regarding the methylation process and coastal wetland wetting/drying patterns may lead to coordinated sampling efforts if new funds are found.

GLRI 67/588 – Forecasting Potential Phragmites Coastal Invasion Corridors

- Field sampling occurred at the Ottawa NWR, including the sharing of detailed vegetation

mapping data. Extensive stands of *Phragmites* on the refuge helped tune the GLRI 67/588 models.

The intense long-term data collection involved in this study directly relates to the delisting of BUIs in the Maumee River AOC (specifically collecting quantitative and repeated phosphorus, fish and wildlife population, and habitat data to evaluate progress toward delisting four BUIs: *Degraded Fish and Wildlife Population*, *Eutrophication or Undesirable Algae*, *Recreational Water Quality Impairment*, and *Loss of Fish and Wildlife Habitat*) and is already providing technical guidance to restoration efforts in the Maumee River and North Maumee Bay of Lake Erie (e.g., a \$2.5M NOAA GLRI award to The Nature Conservancy to restore over 735 acres of coastal wetland habitat at the Erie Marsh Preserve), the Maumee River AOC (e.g., a \$1.3M NOAA AOC Habitat Restoration Fund award to The Nature Conservancy to build fish-passage structures and restore 512 acres of coastal wetland habitat in the FWS Ottawa National Wildlife Refuge), the Saginaw River watershed (e.g., a \$1.5M National Fish and Wildlife Foundation award to Ducks Unlimited and USFWS to restore 940 acres of agricultural land in the Shiawassee National Wildlife Refuge to coastal wetlands), and several other projects along the Michigan and Ohio coasts of Lake Erie.

The water-quality sampling being conducted in the Maumee River Priority Watershed to continue documentation and analysis of significant total phosphorus and other nutrients reductions in waters flowing from restored coastal wetland habitats provide a baseline for other sites within the Maumee River AOC, western basin of Lake Erie, and the Shiawassee NWR and Saginaw River to help understand and document progress toward the delisting of the *Eutrophication or Undesirable Algae* BUI.

Work in FY 2013 will continue to evaluate the impact that *Phragmites*, common carp, and other exotic and invasive species have on the restoration of ecological functions and explore how restoration projects involving Integrated Pest Management based invasive species control efforts (e.g., install carp exclusion grates only during periods when carp spawn) could increase ecosystem resiliency against invasion.

Collaborative Arrangements

Investigators are in contact with many other organizations (USFWS Ottawa National Wildlife Refuge, USFWS Shiawassee National Wildlife Refuge, The Nature Conservancy – Michigan and Ohio, Ducks Unlimited, Michigan Department Natural Resources, Ohio Department Natural Resources, Ducks Unlimited Canada, University of Manitoba) that are implementing or planning to implement similar wetland restoration projects throughout the western Lake Erie landscape (Maumee River AOC), Saginaw Bay (Saginaw River/Bay AOC), and Lake Manitoba.

Budget Information

Personnel	\$ 36,975
Fringe benefits	\$ 9,244
Travel	\$ 14,000
Equipment	\$ 2,000
Supplies	\$
Contracts	\$ 230,502

Indirect costs	\$ 15,406
Total	\$ 308,127

Template 72 – Restoration of Great Lakes Native Fish Community Resilience as a Buffer to Invasive Species Expansion

Total funding: \$336,298

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

Three native species (Atlantic salmon, bloater, lake herring), comprising both predator and prey species, are currently being reared and released in Lake Ontario under this template in an attempt to restore ecosystem stability over multiple trophic levels. Template 72 is attempting to restore a resilient native Great Lake fish community to help curb the expansion of invasive species. Information generated from this study should have transferability throughout all of the Great Lakes.

Using principles of applied science, USGS scientists are identifying techniques and strategies that will provide the highest probability of success for native species restoration in Lake Ontario for Atlantic salmon, deepwater coregonids (bloaters) and shallow water coregonids (lake herring). USGS is uniquely positioned to carry out the full array of restoration strategies, including fish propagation and post stocking evaluation for Atlantic salmon. Because of the complexities associated with the extirpation or decline of native fish species in the Great Lakes there is no single remedy suitable for the restoration of all species. Recent increases in the abundance of coregonids in the upper Great Lakes are coincident with dramatic declines in alewife populations. Unfortunately, although alewife populations in Lake Ontario are declining, there are no deepwater coregonids remaining in the lake to enable natural recovery. Consequently, the restoration of coregonids, as well as extirpated Atlantic salmon, must at least initially rely on hatchery-reared fish.

The GLRI funding thus far has been used to complete the construction of an isolation facility that allows researchers to bring both adults and eggs from the wild and hold, spawn, and rear them, and release appropriate life stages for restoration efforts. Continued project funding enables purchase and rearing of Atlantic salmon and coregonid eggs for rearing and release in adaptive management studies and the potential for native fish restoration techniques to be advanced for trial in other Great Lakes.

Milestones

- Approximately 80,000 fall fingerling Atlantic salmon were released in Lake Ontario tributaries in September - October 2012. Another 8,000 fall fingerling salmon were released in St. Lawrence River tributaries in October in partnership with the St. Regis Mohawk Tribe.
- Media event held for the Atlantic salmon releases – October, 2011.
- Media event and open house held for the new GLRI funded isolation building coming on line – January, 2012.
- Approximately 10,000 Atlantic salmon yearling smolts were released in Lake Ontario tributaries in April, 2012.

- Approximately 1,300 bloater juveniles (eggs originating from Lake Michigan) were released in Lake Ontario in November, 2012.
- Approximately 13,000 lake herring juveniles were reared and released in Lake Ontario in November, 2012.

Measures of Progress

4.3 Number of species delisted due to recovery.

4.4 Percent of recovery actions implemented for priority listed species.

4.5 Percent of populations of native aquatic non-threatened and endangered species self-sustaining in the wild.

This project is promoting implementation of the GLRI Great Lakes Action Plan by providing information on adaptive management strategies for restoring native fishes in the Great Lakes:

Focus Area 4: Habitat and Wildlife Protection and Restoration.

Goal 1: Protection and restoration of Great Lakes aquatic and terrestrial habitats, including physical, chemical, and biological processes and ecosystem functions, maintain or improve the conditions of native fish and wildlife.

Goal 2: Critical management activities protect and conserve important fish and wildlife populations.

Goal 3: Sound decision making is facilitated by accessible, site specific and landscape-scale baseline status and trend information about fish and wildlife resources and their habitats.

This work supports those objectives and measures related to propagation of native species (measures 3, 4, and 5).

EPA Focus Areas on Invasives and AOCs: Restoration of native fishes is best implemented in areas with reduced invasive species (such as alewives) and demonstrates the BUI in former AOC.

Collaborative Arrangements

Funding from this template supports restoration of native Atlantic salmon, bloater, and lake herring in Lake Ontario by raising fish, reintroducing them and conducting survival assessments to evaluate success of applied science native fish restoration strategies. USGS scientists are working closely with NY Department of Environmental Conservation, USEPA, tribal, and Canadian agencies (OMNR) to ensure that the scientifically-based techniques and strategies used provide the highest probability of rehabilitation success and avoid potential fish diseases. This project will have direct application to native species restoration throughout the Great Lakes.

Budget Information

Personnel	\$ 56,497
Fringe benefits	\$ 17,375
Travel	\$ 1,000
Supplies	\$ 15,000
Equipment	\$ 15,000
Contracts	\$ 214,611

Indirect costs	\$ 16,815
Total	\$ 336,298

Template 74 - Changes in Nutrient Transfer within Great Lakes Food Webs: Implications for Fish

Total funding: \$275,553

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

Prey fish population declines and prey fish community changes have occurred in each of the Great Lakes over the past decade with negative implications for lake trout restoration and the success of important recreational and commercial fisheries. Factors underlying these changes are often not well understood within or among the lakes as the lakes differ in prey species, invasive species, and productivity. During EPA's year of intensive sampling, which annually rotates among the lakes, USGS has been sampling each lake's food web, from nutrients to top predatory fish, along a nearshore to offshore gradient to determine if changes in lower trophic levels are driving declines in prey fish biomass that support important fisheries. By deploying similar sampling designs across all of the Great Lakes, USGS can make food web comparisons across lakes where differences in productivity, the degree of invasiveness, and the history of management can provide contrasts that will hopefully elucidate whether prey fish declines are being driven by a common factor or if independent factors are operating in each lake. FY 2013 funding will support Lake Erie CSMI work that will occur in 2014.

Lake Michigan (2010): Two transects were sampled monthly in northern Lake Michigan at three depths. We are evaluating whether fish predation can regulate spiny water flea population and evaluating whether secondary production declines from nearshore to offshore. A Lake Michigan decision support tool has also been developed that will allow fishery managers to explore different stocking scenarios to support restoration of native lake trout.

Lake Superior (2011): Seasonal collections were made along three transects at 20, 50, and 110 m. Summer samples were collected at 56 random locations throughout the lake at depths from 7 to 300 m. Lake Superior has the most intact native fauna among the Great Lakes, so these data provide a baseline of energy transfer information for comparison to the other lakes.

Lake Huron (2012): Similar to Lake Michigan, two transects were sampled monthly in northern and central Lake Huron. Following up on knowledge gained from the 2007 CSMI year, we are evaluating spatiotemporal overlap of planktivores (such as spiny water flea) and zooplankton prey. We are evaluating whether secondary production declines from nearshore to offshore-hypothesizing less of a "nearshore" shunt than in Lake Michigan because of lower densities of quagga mussels in Lake Huron relative to Lake Michigan.

Lake Ontario (2013): USGS is currently working with partners to execute similar nearshore to offshore depth stratified sampling as accomplished in the upper lakes, at three sites along the south shore. USGS is working with partners (NYSDEC and OMNR) to secure additional transects in US waters and/or additional transects along the north shore in Canadian waters. Additional funding supplied by EPA region 2 will be used to study predator diets from angler-

caught salmonids and from smallmouth bass and yellow perch captured with gill nets nearshore.

Lake Erie (2014): Similar to Lake Ontario, advance funding enables USGS to build cross agency collaborations for improving sampling efficiency and leveraging increased partner participation and funding for FY 2014 efforts.

Milestones

Lake Erie: Sampling would follow the common study design used at the other lakes to enhance cross-lakes trophic transfer evaluations. Lake Erie's geomorphology is highlighted by three interconnected, yet ecologically distinct, basins that differ in watershed input influences, bathymetry, and trophic status. Thus, sampling would occur at transects within each basin. Targeting all three basins for sampling will inherently include environmental stressors that are of interest to Great Lakes restoration. For example, western basin sites are expected to be influenced by sediment and phosphorus loading, central basin sites are expected to be influenced by seasonally varying dissolved oxygen availability, and eastern basin sites are expected to be influenced by a stronger nearshore to offshore productivity gradient with implications for native fish restoration as seen at the other Great Lakes that are impacted by invasive dreissenid mussels. By engaging this energy transfer question in all three lake basins, this project will incorporate some of Lake Erie's largest environmental and ecological stressors to increase our understanding of impairments and restoration needs.

Measures of Progress

4.4 Percent of recovery actions implemented for priority listed species.

2.3 Number multi-agency plans established, mock exercises to practice rapid responses carried out under those plans, and/or actual rapid response actions

Understanding the effects of invasive invertebrates and fish on the flow of energy through the food chain is essential in aiding managers with appropriate information for fish restoration efforts. This project is promoting implementation of the GLRI Great Lakes Action Plan as well as areas of increased emphasis by GLNPO for FY 2012 and FY 2013.

By providing a framework for understanding the effects of changing conditions (nutrients, invasive species), pest management control options, and management concerns (fish restoration), this work supports focus areas 2 and 4 of the Great Lakes Action Plan.

Focus Area 2: Invasive Species

Goal 5: An effective, efficient and environmentally sound program of integrated pest management for invasive species is developed and implemented, including program function of containment, eradication, control and mitigation.

Measure 3. Will provide models to determine effectiveness of control plans.

Focus Area 4: Habitat and Wildlife Protection and Restoration.

Goal 1: Protection and restoration of Great Lakes aquatic and terrestrial habitats, including physical, chemical, and biological processes and ecosystem functions, maintain or improve the conditions of native fish and wildlife.

Goal 3: Sound decision making is facilitated by accessible, site specific and landscape-scale baseline status and trend information about fish and wildlife resources and their habitats.

Measure 4. Will provide information for recovery action plans.

Collaborative Arrangements

This study is a multi-agency endeavor that includes state, federal, provincial, and tribal entities involved in the lake. These include:

USEPA, US Fish and Wildlife Service, Illinois Department of Natural Resources, Indiana Department of Natural Resources, Michigan Department of Natural Resources, Minnesota Department of Natural Resources, New York State Department of Environmental Conservation, Ohio Department of Natural Resources, Pennsylvania Fish and Boat Commission, Wisconsin Department of Natural Resources, Chippewa-Ottawa Resource Authority, Great Lakes Indian Fish & Wildlife Commission, Ontario Ministry of Natural Resources, Department of Fisheries and Oceans Canada, and Environment Canada.

Budget Information

Personnel	\$ 48,614
Fringe benefits	\$ 13,712
Travel	\$ 8,820
Equipment	\$
Supplies	
Vessel fuel	\$ 84,000
Vials, formalin, etc.	\$ 10,000
Contracts	
Student contractors (2)	\$ 67,100
Stable isotope analysis	\$ 15,000
Water quality & Zoop. analysis	\$ 14,530
Indirect costs	\$ 13,777
Total	\$ 275,553

Accountability, Education, Monitoring, Evaluation, Communication and Partnerships

Template 81 - Watershed Modeling for Stream Ecosystem Management

Total funding: \$44,018

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

Project provides unified information across the Great Lakes Basin for ecosystem restoration, assessment, and management by incorporating models that relate changes in landscape and hydrologic variables and stresses to changes in ecosystem function. The project relies upon regionally consistent hydrologic, biologic, and geospatial data to generate regionally consistent estimates, models, and analysis.

USGS is the Circular A-16 theme lead for hydrographic spatial data. As such USGS has responsibility to coordinate with other federal agencies, states, and other entities the development and stewardship of the National Hydrography Dataset (NHD). USGS also has developed in partnership with EPA the NHDPlus, it has a memorandum of understanding with The Nature Conservancy to study environmental flows and impacts of hydrologic alterations on ecology. USGS has been a lead agency in the development of techniques and methods to estimate streamflow characteristics in gaged and ungaged watersheds and in developing, applying, and coordinating research in ecology and hydroecology.

Products from this research will include a consistent hydrologic dataset of the US Great Lakes Basin built on the 1:100,000 NHDplus and attributed with landscape and aquatic ecologic variables. Empirical models developed for fish distribution, temperature, and streamflow will be developed. A hierarchical lotic habitat classification framework and fish-based lotic habitat classification will be built on the hydrologic dataset. Field sampling and experimental campaigns aimed at testing and improving the lotic classification schemes will be designed. The sampling design will be implemented by coordinating with existing field-based sampling teams and efforts through Federal and State agencies and Universities.

Milestones

March 2012 – draft estimated monthly flows for all stream segments in the 1:100,000 NHDPlus dataset for water years 1950 - 2009 will be completed and sent to state USGS Water Science Centers for review and input.

October 2012 – Review of initial estimates revealed that the initial estimates of streamflow did not vary enough in parts of the Great Lakes Basin. These estimates are being revised with an updated version of AFINCH that will allow for additional explanatory variables and improved regression techniques.

March 2013 – Flows and stream classifications revised using updated flows.

March 2014 – Final estimates of monthly flows for all stream segments in the 1:100,000 NHDPlus dataset for water years 1950 - 2009 and description of processes used to develop these flows will be documented and available.

Measures of Progress

5.2 Number of priority LaMP projects that are completed.

4.7 Number of acres of coastal, upland, and island habitats protected, restored and enhanced.

Focus Area 5: Accountability, Education, Monitoring, Evaluation, Communication, and Partnerships. Two goals from this focus area benefit from this research. The ungaged flow estimates provide key information for assessing tributary streamflow within the Basin to meet:

1. By 2014, a statistically valid and comprehensive assessment, using a probability-based design, of Great Lakes water resources, will be established. The system will integrate shipboard monitoring, remote sensing, automated sampling, and other monitoring or observing efforts. By 2016, the system will be in place for all of the Great Lakes and capable of providing a scientifically justifiable assessment of Great Lakes water resources.
2. By 2014, timely data and information will be provided to decision makers at multiple scales within a framework of established baselines, targets, indicators of progress, and monitoring.

Collaborative Arrangements

State officials are being contacted about the streamflow estimates and stream classification work to coordinate this work with state ecosystem efforts.

Budget Information

Personnel	\$ 33,454
Fringe benefits	\$ 8,363
Travel	\$
Equipment & Supplies	\$
Supplies	\$
Contracts	\$
Indirect costs	\$ 2,201
Total	\$ 44,018

Template 82 - Characterizing Habitat and Food Web Structures across Great Lakes Estuaries

Total funding: \$220,090

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

Work under this project during FY 2013 will build directly on work completed in FY 2010 - 2012, which included:

- 1) intensive and extensive sampling of over 30 rivermouths across all Great Lakes to determine terrestrial and river contributions supporting rivermouth and nearshore food webs;
- 2) specific sampling in Lake Huron (Thunder Bay River) to determine river contributions supporting nearshore and deepwater food webs; and
- 3) sampling in a set of rivermouths in western Lake Michigan to determine effects of AOCs on benthic invertebrates (food source and health).

Based on the broad-scale knowledge gained in our initial three years of work, as well as the need to better understand the effects of phosphorus loading on rivermouth and nearshore food webs, we will focus our efforts during FY 2013 on addressing five specific questions or objectives important to the management and restoration of Great Lakes rivermouths heavily impacted by phosphorus loading. Targeting the Maumee River, Maumee Rivermouth and near shore of western Lake Erie, we will focus our sampling to address the following management-relevant priority questions:

1. How is the development of harmful algal blooms (HABs; e.g., *Lyngbya*, *Microcystis*, *Anabaena*) controlled by spatial variation in phosphorus and nitrogen concentrations?
2. How do spatial patterns in nutrient concentrations and HAB development vary with river discharge and season?
3. Do changes in HAB species composition cause changes in plankton food quality and quantity as measured by seston fatty acid and chlorophyll concentration?
4. Is the growth, survival, and health of algal grazers (e.g., *Dreissena polymorpha*) negatively affected by development of HABs?
5. Is the health of resident fish (as measured by tissue fatty acid concentration and character) negatively affected by development of HABs?

Research planned for 2013 will focus on assessing spatial and temporal variability of biotic impacts resulting from phosphorus enrichment in the Maumee River proper, the rivermouth and the nearshore zone of Lake Erie. This well-studied river and rivermouth ecosystem is heavily impacted by phosphorus loading from upland agricultural sources – resulting in hyper eutrophication, as exhibited by dense blooms of cyanobacteria (esp. *Lyngbya*, *Microcystis*, and *Anabaena*) as well as concomitant aesthetic and ecological impairments. Specific impairments to be examined include elevated levels of the toxin microcystin, anoxia and hypoxia, and suspected reductions in food availability within food webs supporting economically important fisheries (e.g., walleye). While the patterns of phosphorus and nitrogen loading are well known,

the spatial and temporal impacts on food web interactions and organism health in the Maumee ecosystem are not. Further, the timing of algal blooms in relation to simultaneous changes in river discharge, nutrient concentration, water temperature, and light availability are poorly understood. Moreover, variables such as spatial variation in water depth, velocity, light penetration, substrate and hydraulic retention time are known to influence nutrient and algal dynamics, but little is known about these factors in the Maumee River system. We propose to examine patterns of biological response in space and time to hydrologically-driven changes in phosphorus and nitrogen concentrations in the Maumee River and near-shore Lake Erie ecosystem. Biological responses include: 1) algal species composition and biomass (including biovolume and chlorophyll concentration), 2) growth, health, and survival of algal feeding invertebrates (*Dreissena polymorpha*), 3) quality and compositions of seston food resources (algal fatty acids), and 4) health of age-0 fish in late summer, via analysis of tissue lipid and fatty acid composition.

Sampling will occur during spring and fall at ~30 – 50 sites across the Maumee Bay (rivermouth), Lake Erie nearshore zone, and up-river sites. Physical data, including water depth, temperature, TSS, light penetration, phosphorus (TP, SRP, PP), nitrogen (TN, NO₃, NH_x, PN), conductivity, and pH will be used to characterize conditions promoting changes in algal composition and food quality through space and time. These data will be important to help build models linking hydrology, nutrient loading, and ecosystem processes are not yet fully characterized or quantified in the Maumee River mouth and nearshore Lake Erie.

Effects of algal composition (species and tissue lipid quality) on growth and survival of algal grazers will be estimated by suspending cultures of *Dreissena* of known mass and size distribution throughout the Bay in early summer; cultures harvested in fall will be measured for survival, growth, and tissue fatty acid composition (health metric). Age-0 fish will be sampled in late summer for determination of species abundance, size, and mass. A subsample (~ 100 ind.) will be analyzed for tissue fatty acid and lipid content as an indicator of health.

Final results will be mapped for display of changing nutrient-driven hotspots of algal bloom development, algal-grazer production, and food web trophic relations. Further, data will be used to estimate the role of hydrologic mixing (river and lake water) in determining the timing and effects of nutrient-controlled HAB and algal-controlled effects on invertebrate grazer growth and mortality.

The Maumee River has been designated as an Area of Concern (AOC), with ten identified Beneficial Use Impairments. This work will address four specific Beneficial Use Impairments in this important rivermouth: Eutrophication or undesirable algae; Degradation of fish and wildlife populations; Degradation of aesthetics; and Loss of fish and wildlife habitat.

Milestones

- We will determine spatial patterns of phytoplankton species, mass, and food quality (fatty acid and chlorophyll content) in relation to variation in hydrology, nitrogen and phosphorus species concentrations, light penetration, and water temperature in the Maumee River, rivermouth and nearshore zones of Lake Erie.
- We will measure relationships between the development of harmful algal blooms (HABs) and the growth and survival of an invasive algal-grazing invertebrate (*Dreissena*

polymorpha).

- We will determine relationships between the development of harmful algal blooms (HABs) and metrics of the health of age-0 fish.
- We will produce maps exhibiting patterns of HAB formation in relation to nutrient concentrations, light regime, and water temperature useful to for future prediction.
- Data analyses from prior years (FY 2010 - 2012) sampling will be completed.

Measures of Progress

5.2 Number of priority LaMP projects that are completed.

1.2 Area of Concern Beneficial Use Impairments removed.

3.1 Five year average annual loadings of soluble reactive phosphorus from tributaries draining targeted watersheds.

4.8 Percent of U.S. coastal Great Lakes wetlands assessed.

4.9 Number of habitat-related Beneficial Use Impairments removed from the 27 U.S. Areas of Concern so impaired.

Information generated from spatially intensive sampling in FY 2013 will help better understand what will be required to restore impacted rivermouths (e.g., AOCs) and to remove existing BUIs, specifically including (3) degradation of fish populations, (5) animal reproduction problems, (8) eutrophication, (11) degradation of aesthetics, (12) added costs to agriculture, (13) degradation of phytoplankton and zooplankton populations, and (14) loss of fish habitat. This work will also contribute to better understanding factors controlling growth and survival of a persistent aquatic invasive, *Dreissena polymorpha*. Finally, this information will contribute directly to specific Measures of Progress for each of the following Focus Areas and goals:

Focus Area 1: Toxic Substances and Areas of Concern:

Goal 5. Our analyses of benthic invertebrate health and food source in rivermouth AOCs and similar non-AOC rivermouths (measured in 2012) will provide metrics of impairment and baseline information for restoration targets and benchmarks.

Focus Area 3: Nearshore Health and Nonpoint Source Pollution: Our analyses of the condition and health of fisheries and supporting food webs in the phosphorus-impacted Maumee River and nearshore areas will provide critically important information for Goals 1, 2, 5, and 6:

Goal 1. Determination of health and food source quality (lipid quality and quantity) in river, rivermouth and nearshore benthos.

Goal 2. Measurement of land-use and land-cover impacts on nearshore and rivermouth food web health focused on target benthic invertebrates and fish species.

Goal 5. Determine patterns of land-use and land-cover and their effects on nutrient transformations and incorporation by river, rivermouth and nearshore consumers.

Goal 6. Our field measurements will be unique, of high quality, timely, and provide relevant information about nearshore areas useful for future management, protection, and restoration of these dynamic ecosystems.

Focus Area 4: Habitat and Wildlife Protection and Restoration: Our analyses of the condition and health of fisheries and supporting food webs in the phosphorus-impacted Maumee River and nearshore areas will provide critically important information for the following goals:

Goal 1. Provides new insight into the ecosystem functions and biological processes critical to maintain and restore conditions of native fish (e.g., determine patterns of watershed and lake-shed control of lipid-rich food production and consumption; hydraulic controls of high quality food supplies delivered to rivermouth ecosystems from lakes).

Goal 3. Provides site-specific and landscape-scale baseline status about biological and ecosystem processes supporting fisheries and their habitats (e.g., characterize land use effects [phosphorus enrichment] on development of low quality and potentially toxic algal food resources in river, rivermouth, and nearshore areas, and their effects on resident fish).

Focus Area 5: Accountability, Education, Monitoring, Evaluation, Communication, and Partnerships: Our monitoring in embayment and nearshore areas will provide critically important information for the following goals:

Goal 1. A cooperative monitoring and observing system provides a comprehensive assessment of the Great lakes ecosystem. To help meet:

Objective 5: a refined suite of science-based indicators for development of a comprehensive assessment of Great Lakes ecosystem health will be identified.

Objective 9: a comprehensive assessment of Great Lakes water resources that include monitoring and observing efforts. And,

Objective 10: provide timely data and information to decision makers.

Sampling in 2013, combined with results of 2010 - 2012 activities, will result in development of a rivermouth conceptual model that will improve understanding of how flows and nutrients are assimilated and processed as rivers enter the Great Lakes. This has direct application for understanding the fate of contaminants in Areas of Concern, guiding restoration efforts and targets so that outcomes are more predictable, and understanding the role of rivermouths as habitat.

Collaborative Arrangements

We will coordinate with the GLRI project, development and application of a habitat model for the Lower Maumee River AOC, on site selection, data analyses and model development. We will also continue to interact with scientists and managers instrumental in development of The Great Lakes Rivermouth Collaboratory, particularly scientists at the USEPA laboratory in Duluth, USGS Water Science Centers in Ohio, Michigan, and Ohio.

Budget Information

Personnel	\$ 145,621
Fringe benefits	\$ 29,124
Travel	\$ 11,840
Equipment	\$
Supplies	\$ 2,000
Contracts	\$ 20,500
Indirect costs	\$ 11,005
Total	\$ 220,090

Template 84 - USGS GLRI Database

Total funding: \$352,145

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

Providing easily accessible, centrally located, USGS biological, water resources, geological, and geospatial datasets for Great Lakes basin restoration activities coordinated with GLOS. Managers, partners and the public will be able to readily access this information in usable interactive formats to help plan and implement restoration activities. Building tools and infrastructure to support standard data access, efficient data discovery and dynamic mapping of watersheds and their hydrologic properties. Developing decision support tools to enhance scientific investigation or disseminate project findings, for example integrating hydrologic models with real-time data streams in order to assess the potential environmental impacts of climate change on stream water quality. Partners include Great Lakes states, EPA, and other federal management agencies.

Milestones

Work with GLRI project Principle Investigators to gather project metadata, load metadata into the project catalog, and integrate project datasets into the project catalog in order to make them easily available on the web.

- Continue to work with other GLRI colleagues to maintain USGS GLRI web presence (<http://cida.usgs.gov/glri/>)
- Continue to make project data discoverable and accessible through USGS GLRI data catalog as datasets are finalized and published (<https://cida.usgs.gov/glri/geonetwork>)
- Continue to work with other GLRI projects to develop innovative applications for supporting scientific endeavors as well as communicating science outcomes. Examples include:
 - Environmental Data Discovery and Transformation (EnDDaT) system: <https://cida.usgs.gov/enddat/>
 - SPARROW Model Decision Support System: http://cida.usgs.gov/sparrow/map.jsp?model=42&session=tp_pcs_zero_maumee
 - Water-Quality Data Access: <http://qwwebservices.usgs.gov/portal.html>
- Near Real-Time GLRI GLOS Interactive Data Viewer: In development.
 - Access to Real-Time Data: <http://nwisvaws02.er.usgs.gov/ogc-swie/Map.jsp?dataSet=GL>
 - GLRI *Phragmites* Decision Support Tool (in review).
 - GLRI Hydrologic Forecasting Tools: In development.
- Collaborate with other non-USGS GLRI partners to evolve broad data management strategy that includes standardized ways of sharing and using other observed and modeled environmental conditions.

Measures of Progress

5.2 Number of USGS GLRI projects with published metadata records and published datasets where applicable.

Database and decision support tools will contribute to:

Focus Area 5: Accountability, Education, Monitoring, Evaluation, Communication, and Partnerships: through

Goal 2: The necessary technology and programmatic infrastructure supports monitoring and reporting, through

Objective 10: timely delivery of data and information provided to decision makers at multiple scales within a framework of established baselines, targets, indicators of progress, and monitoring

Collaborative Arrangements

- Collaboration with GLOS and NOAA with the IOOS Regional Association.
- Work with Environment Canada through the Great Lakes GEOSS Testbed.
- Coordinate closely with USGS GLRI Wisconsin Internet Mapping (WIM) Team for web mapping capabilities and USGS GLOS project for real-time data access.

Budget Information

Personnel	\$ 263,284
Fringe Benefits	\$ 68,454
Travel	\$ 2,800
Equipment	\$
Supplies	\$
Contracts	\$
Indirect Costs	\$ 17,607
Total	\$ 352,145

Template 183c - Quantifying Sediment and Nutrient Loading in the Massena, NY “Area Of Concern” and the St. Lawrence Connecting Channel as a Criteria for BUI Delisting

Total funding amount (Gross funds): \$90,000

Authority for work: USGS Organic Act, 43 USC 36c and General Cooperation Authority 43 U.S.C. 36c

Description of work

Since 2010, connecting channels have been included in each of the Great Lakes’ Lake Management Plans (LaMPs). Lake Ontario now includes both the Niagara River and the St. Lawrence River. The Niagara River is well characterized by a number of long-term programs, but because of the lack of tributary water-quality data, the St. Lawrence River and the adjacent Massena Area of Concern (MAOC) constitute a data gap in the information needed for the LaMP and the Area of Concern (AOC). Critical information needs include basic water-quality parameters, total suspended solids, nutrients and flow data. These data are needed to aid in the identification of sources of water quality impairment in the MAOC and to supply additional information to help de-listing efforts. Additionally, this information will help define the St. Lawrence connecting channel and tributary characteristics.

The monitoring network will consist of seven sites on four rivers (the St. Lawrence and three tributaries: Grass River, Raquette River, and St. Regis River), and will include monitoring three locations, upstream of the MAOC, one each on the Grass, Raquette, and St. Regis rivers and at one location within or just downstream of the MAOC, on each of the three tributary rivers. In addition, the St. Lawrence River, which is located near the MAOC, will also be sampled. Four samples will be collected during the first year of monitoring, starting in FY-13. These samples will be scheduled at equal temporal intervals based on beginning date of the project. Comparison of water-quality data from upstream to downstream sites will be useful in assessing the impact of sources within the MAOC to sources outside the MAOC.

Field, laboratory, and flow parameters will be measured at each site during each visit. Field parameters will be collected at each site and will include pH, temperature, and specific conductance. Samples will be collected and analyzed for Total Suspended Sediment and nutrients: [Ammonia as N, Nitrite, nitrite+nitrate, and Total Nitrogen] and [Orthophosphate (soluble reactive Phosphorous) and Total Phosphorous]. In cases where USGS flow data are not available, flow data will be collected at the site according to USGS protocols. Analytical methods corresponding to those used in the GLRI Lake Ontario tributary sampling being performed by the USGS as part of template 153b will be used. One quality assurance sample will be collected per round of sampling; a total of two blanks and two replicates will be collected over the four sampling rounds. Analytical data results will be reported to the EPA using spreadsheets and will also be available through the USGS National Water Quality Information (NWIS) site for the public. These data will be provided within three months of the end of sample collection.

Milestones

- Field samples including, water-quality samples, physical parameters and flow are

collected on a quarterly annual basis from 7 sites.

- Samples are processed, preserved, and sent to the USGS Central lab in Denver Colorado within 24 hours of collection
- Within three months of sending in samples, results are reviewed and made public on the USGS NWIS web site as standard USGS procedure.
- Semi-annual updates are provided to EPA, and all data are tabulated and presented in the USGS NY Annual Data Report. Data are summarized and tabulated in a spreadsheet for USEPA annually.

Work funded by this template will establish a basic monitoring network on one of the connecting channels of Lake Ontario, and will provide additional information needed to help EPA and NYS DEC make decisions to de-list selected Massena AOC BUIs.

Measures of Progress

1.2 Area of Concern Beneficial Use Impairments removed

5.2 Number of priority LaMP projects that are completed.

3.1 Five year average annual loadings of soluble reactive phosphorus from tributaries draining targeted watersheds

This work will be essential to achieving a number of Great Lakes Restoration Action Plan objectives for Focus Area 3, Near shore Health and Nonpoint Source Pollution, including:

- By 2014, a baseline will be established for (1) total suspended solids, (2) filtered and unfiltered nutrients loadings from 6 tributaries to the Massena AOC and one site nearby on the St. Lawrence River at Cornwall. This work will collect the water-quality data needed to develop baseline total suspended solids loadings from sub-basins within the St. Lawrence River basin and in the Massena AOC area in New York.
- By 2014, source areas of water quality impairment will be identified for soluble phosphorus loading in targeted tributaries. This work will develop a comprehensive characterization of soluble phosphorus loadings from which future reductions can be measured.

Also, in support of objectives for Focus Area 5: Accountability, Education, Monitoring, Evaluation, Communication, and Partnerships, including:

Goal 1. A cooperative monitoring and observing system provides a comprehensive assessment of the Great lakes ecosystem.

Objective 9: a comprehensive assessment of Great Lakes water resources that include monitoring and observing efforts.

Objective 10: provide timely data and information to decision makers

Collaborative Arrangements

Laboratory analyses will be done by the USGS Central Laboratory in Denver Colorado. USEPA Region 2 staff will help design the monitoring framework and provide assistance in the field when appropriate and required.

Budget Information

Personnel	\$ 44,080
Fringe Benefits	\$ 11,020
Travel	\$ 18,400
Equipment	\$
Supplies	\$ 3,600
Contracts	\$ 8,400
Indirect Costs	\$ 4,500
Total	\$ 90,000

Template 330 - Lake-Wide Management Plan (LaMP) Capacity Support by USGS

Total funding: \$331,896

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The USGS LaMP objectives include:

- Providing USGS expertise, capacity and support for Great Lakes programs
- Participating in LaMP processes, programs, conferences, workshops and projects, including the development of LaMP documents and updates
- Serving on work groups and technical committees
- Participating in interagency actions that implement LaMP programs and priorities
- Incorporating LaMP goals into USGS planning efforts

Overall LaMP efforts include compiling monitoring and research information into the Great Lakes web mapper (Mapper). The Mapper's focus is on information that will result in recognition of areas where data are being collected, missing or sparse, and on areas where ecosystems are vulnerable. The development of a nearshore-coastal framework will be used in conjunction with the Mapper to develop a strategy for coordinated research and monitoring. The Mapper and framework will assist decision-making for protecting and restoring Great Lakes ecosystems. In addition a part-time USGS employee is co-located with the USEPA, GLNPO office to provide overall coordination of LaMP activities.

Activities of individual USGS Science Centers include coordinating with partners in each of the Great Lakes and support of sampling and monitoring activities as follows:

- For Lake Huron, emphasis is on issues affecting fisheries and nutrient inputs, particularly in the Saginaw basin, and on the development of the Mapper and nearshore-coastal framework to assist partners in making management decisions.
- For Lake Superior, emphasis is on support of activities with partners in compiling and collecting data focused on Areas of Concern, nutrients, and impacts from potential metal mining.
- For Lake Michigan, efforts include support of a near-shore, coastal framework white paper and coordination effort, the Mapper, as well as support for weekly discussions with the Lake Michigan GLNPO LaMP coordinator. Other work includes coordination with other agencies, such as with:
 - The National Park Service, USEPA and other Federal, state and local stakeholders in the Urban Waters Federal Partnership –Northwest Indiana pilot area on mapping and water quality activities.
 - Stakeholders who regulate or produce water from nearshore parts of Lake Michigan to share information from GLRI-sponsored tributary monitoring of water quality,
 - The U. S. Army Corps of Engineers on water-quality data related to a major navigation and remediation dredging project in the Grand Calumet River Area of Concern,
 - National Park Service to operate streamflow gages on Lake Michigan tributaries, and

- USEPA on an investigation of benthic invertebrates in the Lake Michigan near shore near Gary, Indiana.
- For Lake Erie, emphasis is on coordinating activities with partners, compiling data for the Mapper, and supporting the nearshore-coastal framework.
- For Lake Ontario, work consists of coordinating activities with the EPA for de-listing projects at Areas of Concern in both the St. Lawrence/Massena and Rochester Embayment areas.
- Activities of the Great Lakes Science Centers include coordinating with partners in each of the Great Lakes and on support for near-shore sampling and monitoring activities and development of the nearshore-coastal framework and strategy.

Milestones

Emphasis has been placed on construction of the Great Lakes web mapper (Mapper) to support the needs of individual lakes and for the entire Great Lakes Basin. The mapper will provide location and contact information about monitoring and research efforts conducted in the Great Lakes Basin. An on-line data entry tool has been developed and a mapper website will be advertised widely during the year to collect as complete a picture of Great lakes monitoring and research as possible. A white paper describing a conceptual framework for Lake Michigan nearshore ecosystem and relevance to Lake Michigan Lakewide Management Plan goals has been prepared and is being readied for publication. The framework described in the paper will be used in discussions about a Great lakes wide nearshore-coastal monitoring and research strategy.

Data available in the USGS NWIS database have been evaluated and availability captured on the Mapper. This effort includes providing information on current levels of toxic substances to help reduce future exposure to toxic substances from historically contaminated sources through source reduction and other exposure reduction methods.

Information about the health of watersheds is provided to aid in management decisions that will assist protection of near-shore health. Land-use information is used for management decisions to ensure that near-shore aquatic, wetland, and upland habitats can sustain the health and function of natural communities. Information about loading of sediments, nutrients and pollutants to tributaries is provided to determine whether reductions of these potentially harmful constituents can be achieved.

Site-specific and landscape-scale baseline status and trend information about aquatic resources are provided to aid management decisions. Preliminary data on stream sediments in three Lake Superior watersheds with on-going exploration or development for metal mining indicate broad differences in baseline metal values across the region. This supports the need for regional baseline studies in Great Lake Basins with high potential for metal mining (i.e., Lake Superior and Lake Michigan). Assessments of high-priority actions, identified in strategic plans (such as state and federal species management, restoration and recovery plans, Lakewide Management Plans, Remedial Action Plans, and others) are provided to assist in the achievement of goals for the Lakes.

Measures of Progress

5.2 Number of priority LaMP projects that are completed.

In support of objectives for Focus Area 5: Accountability, Education, Monitoring, Evaluation, Communication, and Partnerships, including:

Goal 5: Work under the goals and objectives of the Great Lakes Water Quality Agreement is coordinated between the U.S. and Canada through Lakewide Management Plans (LaMP) and other binational processes.

Objective 8: improved coordination with Canada will take place for programs under the Great Lakes Water Quality Agreement, particularly under the LaMPs, which will result in the achievement of 5-10 priority LaMP goals and actions.

Objective 10: provide timely data and information to decision makers.

Collaborative Arrangements

LaMP efforts include coordination with tribal natural-resources departments, the USEPA, and state agencies. Scientists work closely with partners to assure that products and results are applicable and useful. A new emphasis on "strategic coastal science" is proposed. This would include a strengthened partnership with the Great Lakes Commission to broaden our work and research with the Commission and other coastal management agencies.

Budget Information

Personnel	\$ 230,280
Fringe Benefits	\$ 61,020
Travel	\$ 12,000
Equipment	\$ 2,000
Contracts	\$ 10,000
Indirect Costs	\$ 16,596
Total	\$ 331,896

Template 332 - Implementation of the Great Lakes Observing System

Total funding: \$352,145

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

This project will provide direct support for Great Lakes Observing System (GLOS) Department of Interior backbone activities within the Midwest Region office of the U.S. Geological Survey, including:

- The deployment and support of observation platforms;
- Water-quality statistical models to link constituents in laboratory-analyzed samples with in-stream continuous-sensor measurements;
- Watershed models to better assess sources and sinks of nutrient contamination, including:
 - HSPF models for the Saginaw and Tonawanda watersheds will provide a framework for evaluating hydrology and water quality loading for sediment and other water-quality parameters for the two basins. Parameters developed for these models will be transferrable to other watersheds within the Great Lakes with similar hydrogeologic characteristics;
 - Top model and WATER model development for the Great Lakes; and
 - HydroSPARROW modeling to determine land use and climate change impacts on water quality;
- Information system infrastructure development and implementation to provide a data platform to support real-time decision support needs, including:
 - Participation in the Great Lakes Testbed of GEOSS (Global Earth Observation System of Systems) provides linkages to similar data from Canadian agencies;
 - Development of a Decision Support System that leverages the GLOS Data Network. Initial focus for DSS is on nutrient fluxes to key tributaries around the Great Lakes. The System will aid in AOC delisting by providing access to consistent monitoring data with broad spatial coverage necessary for understanding whether nutrient reduction goals have been met; and
 - A tool called EnDDaT is being developed with the GLRI Beaches project to integrate real-time data relevant for beach and other nearshore modeling.

Milestones

- Continue to work with NOAA and GLOS to make additional Great Lakes datasets accessible according to IOOS standards as described in the GLOS Enterprise Architecture study.
- Launch Environmental Data Discovery and Transformation (EnDDaT) tool to integrate real-time data relevant for beach and other nearshore modeling.
- Continue to support and acquire and test equipment needed to develop near-real-time estimates of analytes including wastewater-related compounds and mercury.
- Develop water-quality statistical models of surrogate relationships and time series estimates of loads in support of nearshore and toxic chemical GLRI projects.
- HydroSPARROW - The framework (computer code) has been completed integrating the

SPARROW model with TopModel and WATER models; Effects of Land Use Changes on nutrient inputs have been estimated but need to be quality assured; Preliminary changes in streamflow have been estimated.

- HSPF Models of Kalamazoo River (MI) and Tonawanda Cr. (NY) - Kalamazoo River Basin (hydrologic component) have been developed. The Tonawanda Cr. model is in the process of calibration and the hydrologic component for the Tonawanda model is in the final stages of development and testing. The Kalamazoo River model includes development of 13 dam structures, and improved channel thalweg estimations; parameter estimation code has been set up for calibration of the model and tested; sediment components have been included and results evaluated.

Measures of Progress

5.2 Number of priority LaMP projects that are completed.

5.3 Number of educational institutions incorporating new or existing Great Lakes protection and stewardship criteria into their broader environment education curricula.

1.2 Area of Concern Beneficial Use Impairments removed

The Great Lakes Observing System coordinates and integrates regional coastal observations supporting national and regional priorities including Great Lakes restoration. The DOI backbone project provides instrumentation and testing of new technologies for real-time observing system information in tributaries, embayments, and the near-shore to determine and guide restoration activities. This includes: monitoring to provide a direct measure of soluble reactive phosphorus concentrations, provide information for BUI removal and for assessing emerging threats; and a coordinated approach to making this information available to decision makers.

In support of objectives for Focus Area 5: Accountability, Education, Monitoring, Evaluation, Communication, and Partnerships, including:

Goal 1. A cooperative monitoring and observing system provides a comprehensive assessment of the Great lakes ecosystem. And

Objective 9: a comprehensive assessment of Great Lakes water resources that include monitoring and observing efforts. And

Objective 10: provide timely data and information to decision makers.

Collaborative Arrangements

Data management is coordinated with partners including NOAA, USEPA and USACE through the Great Lakes Observing System. A multi-agency Enterprise Architecture design has been completed and work continues to integrate USGS sensor networks with GLOS through the use of international standards.

A governing board chaired by GLNPO or a cross section of federal agencies would be helpful in coordinating the overall GLOS activity within GLRI.

Budget Information

Personnel	\$ 233,000
Fringe Benefits	\$ 41,538
Travel	\$ 10,000

Equipment	\$ 50,000
Supplies	\$
Contracts	\$
Indirect Costs	\$ 17,607
Total	\$ 352,145

Template 588 - Forecasting Great Lakes Basin Responses to Future Change

Total funding: \$176,072

Authority for work: USGS Organic Act 43 U.S.C. 31 and General Cooperation Authority 43 U.S.C. 36c

Description of Work

The purpose of this template is to provide insight into the long-term viability of present day restoration investments given expectations of land use and climate change. Such work helps ensure that public and other funds are not directed to restoration projects unlikely to be self-sufficient and viable over societally relevant time scales.

This objective is met by constructing and calibrating a watershed hydrologic model of the Lake Superior Basin suitable for accepting downscaled climate change inputs from a variety of federal and non-federal stakeholders. The model forecasts of future hydrologic flows are vital for restoration, water quantity, water quality, infrastructure, habitat, and other ecological decision making. The work leverages the best current existing data sources into model input (temperature, precipitation), parameterization (soils, slope, etc.), and calibration targets (measured streamflows). The first work element below is similar to FY 2011 - 2012 proposed work, which reflects the extension of work across fiscal years due to previous reductions in funding. Specific FY 2013 GLRI Template 588 work elements would consist of:

- Construct and calibrate a refined NHM/PRMS model of the LSB using historical streamflow records,
- Simulate current and potential future land use and climate change, and demonstrate the suitability for forecasting hydrologic effects of change.
- Link the hydrologic flows to other GLRI funded restoration endpoints: a) forecasts of mercury in Great Lakes fish (collaboration with State of Minnesota and Canada); and b) hindcast and forecasts of flow and temperature effects on Great Lakes tributary spawning (collaboration with University of Wisconsin-Madison Center for Limnology).

Milestones

- Lake Superior Basin hydrologic numerical model calibrated to current conditions; May 2013
- Three scenarios from four GCMs downscaled and run as input to provide 12 climate change scenario examples using the calibrated PRMS model; June 2013
- USGS Scientific Investigation Report documenting the model and climate scenarios run; October 2013
- Link forecasts of hydrologic flows to other GLRI restoration endpoints; July-September 2013

Measures of Progress

5.2 Number of priority LaMP projects that are completed.

3.1 Five year average annual loadings of soluble reactive phosphorus from tributaries draining targeted watersheds

Supports Focus Area 4: Habitat and Wildlife Protection and Restoration Goals 3 and 4: Template objectives and deliverables facilitate more timely data and information assimilation and processing, which in turn is delivered in a form that provides a science-based foundation to decision makers. These deliverables cover multiple scales within a framework that leverages established baselines, targets, indicators of progress, and monitoring.

In support of objectives for Focus Area 5: Accountability, Education, Monitoring, Evaluation, Communication, and Partnerships, including:

Goal 1. A cooperative monitoring and observing system provides a comprehensive assessment of the Great lakes ecosystem. And

Objective 10: provide timely data and information to decision makers.

Collaborative Arrangements

This work benefits from collaboration with NOAA Great Lakes Science Center (Andrew Gronewold), the State of Minnesota mercury in fish GLRI project (Dan Engstrom/Reed Harris PIs), and the University of Wisconsin-Madison Center for Limnology Great Lakes Fish Project (Dr. Peter McIntyre PI).

Budget Information

Personnel	\$ 140,228
Benefits	\$ 24,540
Travel	\$ 2,500
Equipment	\$
Supplies	\$
Contracts	\$
Indirect Costs:	\$ 8,804
Total Costs:	\$ 176,072